Evaluation of feedback and a graphical game element in an SMS intervention to increase attendance among at-risk high school students

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Evaluation of feedback and a graphical game element in an SMS intervention to increase attendance among at-risk high school students

By

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Project Title:

Attendance coach

This is to certify that the above named applicant has completed the Coventry University Ethical Approval process and their project has been confirmed and approved as Medium Risk

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Abstract

Mobile phone text messages have been used to deliver interventions that support positive behaviour in many health contexts. School absenteeism is a problem across the world leading to reduced reading and writing skills and increased likelihood of school dropout. Much of the published research in both the fields of school absenteeism interventions and text message driven behavioural change is not based on theoretical foundations and so it difficult to generalise findings from one study into another context. This thesis describes the development and evaluation of an intervention delivered by text and picture messages that supports reduced school absenteeism among at-risk youth. This thesis describes the intervention design process and its connections with Social Cognitive Theory, the Transtheoretical Model, Theory of Planned Behaviour and Self Determination Theory. A pilot trial was undertaken to evaluate the technical feasibility of the intervention method and findings informed the intervention and study design that was evaluated in two three-arm single blind pre-post randomised controlled trials. The studies compared the effect on absenteeism of two styles of intervention with a control group. The first sent feedback of recent attendance performance in the form of a graphical scoreboard and the second sent the same feedback together with individually tailored autonomy supporting messages based on recent attendance that offered praise and motivational content. When messages were sent immediately after school in Study One, rates of full day absenteeism were reduced by half when compared to the control group. When messages were sent at the time that students woke up to go to school in Study Two, there was no significant difference between the groups. While it was hypothesised that students receiving the autonomy supporting text in addition to the feedback image would have higher perceived autonomy in school and lower absenteeism rates, there was no significant mediating effect. Moderation analysis found that the effect of the feedback on absenteeism was especially strong among participants for whom the primary language spoken at home was Spanish rather than English. These findings further understandings related to the effect of autonomy supporting messages on perceived autonomy and the timing of feedback.

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1 Introduction

This chapter offers a personal view of the motivation and roots of this study. It provides the reader with a brief preview of the project, its goals and a road map of this thesis.

1.1 Motivation and aims

My motivation behind this research is rooted in a broad interpretation of the book, Reality is Broken (McGonigal and Whelan 2012). While the bulk of the book describes examples of turning real life into games, its foundation is based on the observation that people invest large amounts of time and effort in games and that elements of games, in particular feedback and recognition, motivate them to do so. While creating alternative realities and rules around daily life to manufacture game-like scenarios is one approach to taking advantage of this phenomena, I am more interested in simply adding feedback elements to daily life based on task performance and examining whether these can modify behaviour. This idea requires the underlying assumption that the participant is at least interested in their task performance. For example, if one does have not have an interest in gardening, then feedback on the regularity of your weeding efforts is unlikely to have any effect.

Young people have need for many types of behavioural support, some of which have been the focus of technology based supports often focused on health improvement including, adherence to contraception (Castaño et al. 2012, Hou et al. 2010), mental health (Branson et al. 2013), safe drinking (Moore et al. 2013, Suffoletto et al. 2012a, 2012b, Suffoletto and Chung 2016, Suffoletto et al. 2014, 2016), safe sex (Suffoletto et al. 2013, Cornelius et al. 2013, Lopez et al. 2014, Matheson et al. 2014), physical activity and weight loss (Lau et al. 2012, Abraham et al. 2015), and college enrolment (Castleman et al. 2012, Castleman and Page 2015).

It has been estimated that between 5 and 7.5 million children in the US miss nearly a month of school each year (Ginsburg et al. 2014) and the 2013 National Assessment for Educational Progress data showed that students who missed three or more days in the 30 days prior to the test performed lower on

reading and math assessments than those that had not (Ginsburg et al. 2014). In another study of 17,482 students from diverse backgrounds and ethnicities aged 12-17 years old, 11% reported skipping school in the 30 days prior to the survey (Vaughn et al. 2013).

With a background of teaching students at high risk of dropping out of school in the United States, I chose to study the provision of support to those who need it in attending school because, in my experience, most know that they need to attend regularly but find daily motivation difficult. Chapter 2 describes the scale of absenteeism (section 2.2), its effects on students (section 2.3), its causes and predictors (section 2.5) and describes different types of existing interventions that aim to support regular school attendance (section 2.6). Existing interventions often require substantial resources to support a small number of students. However, with cell phone ownership almost ubiquitous among young people in the United States and the associated ability to deliver individualized, immediate and low cost supports, cell phones offer a promising delivery platform interventions.

The research presented here focusses on supporting school attendance not only because of its importance to the students but because the nature of the data available makes it a good foundation for researching computer driven behavioural change. In Texas schools, where this research was undertaken, classroom teachers generally document student attendance for each class period of the day on a centralized database. Its reliability is considered important and staff are allocated (attendance officers and attendance clerks) to verify its accuracy as it is used both as evidence in truancy court hearings and in school funding procedures. This reliable, highly granular, machine readable log of behaviours makes both a good outcome measure for study, but also a good oracle for computer generated feedback.

1.2 Literature outline

Literature in the areas of attendance interventions and behaviour change interventions delivered by SMS shows a paucity of high quality comparative studies (see section 2.6 and 4.2) and the work presented here was designed to address some of the shortcomings identified by reviewers (Maynard et al.

2013, Fjeldsoe et al. 2009) such as random assignment to groups, inclusion of demographic data, clear reporting of data and reporting information about costs of the interventions.

This work also describes a clear theoretical foundation to the design of the intervention that is evaluated. There are no examples of interventions with theoretical foundations in the school attendance literature that the author is aware of though some examinations of the role of Self Determination Theory and the Theory of Planned Behaviour in school absenteeism are explored in section 3.2.9. A similar lack of theoretical foundations is seen in the literature of behaviour change interventions where systematic reviews have found the majority of interventions described to lack theoretical foundations and have even found a negative correlation between an intervention's basis in theory and its effectiveness (Armanasco et al. 2017). Despite this suggestion that theory does not support effectiveness, in this research a strong theoretical foundation was chosen to ensure that the results would further inform theoretical developments and would make the results generalisable to new contexts (Michie et al. 2008).

The theoretical framework used in the design and evaluation of this research was based on the literature surrounding school attendance and text message based behaviour change. Self Determination Theory and the Theory of Planned Behaviour have been used to examine school attendance behaviour previously and those findings were used to shape the content of the intervention messages. Social Cognitive Theory, the Theory of Planned Behaviour and the Transtheoretical Model were the most common theories used in the design of behaviour change interventions driven by text messages and so were also used to inform the design in this thesis. These theories along with others and their implementations in practice are examined in chapter 3.

This thesis asked the following research questions:

RQ1 – Can feedback delivered by SMS change school attendance behaviour?

RQ2 – Which elements of the feedback predict effectiveness: for example: message content, timing, format?

1.3 Methodology outline

A software application was developed to take attendance data from the school management computer system and to generate and send individually tailored messages and graphics to students by SMS (see Appendix 11.2) and a pilot study undertaken to evaluate its technical feasibility (see Chapter 6).

Two randomised controlled trials were conducted to evaluate the impact of the messages on school absenteeism at an alternative high school in Texas that focussed on dropout recovery and at which nearly all students were categorised as "at-risk" of dropping out and most (94% in Study One and 84% in Study Two) were classified as economically disadvantaged. Much of the literature surrounding text message driven behaviour change describes comparisons of the effect of an intervention with a no-treatment control group. While this provides a useful measure of an intervention's effectiveness, it offers little in terms of theoretical insight and little to aid the development of other interventions. This research set out to provide generalisable findings though the use of theoretical foundations and further through its experimental design. Two experimental groups were compared with a no-treatment control in each of the two experiments. The first group was sent a simple graphical representation of their recent attendance performance (see section 6.5.2) and the second received the same graphic together with additional autonomy supporting text modelled on Self Determination Theory (see section 6.5.3). In the first study, the messages were sent immediately after school. In the second, they were sent on the following morning, at the time that the student claimed they needed to wake up in order to get to school on time. This timing was selected in accordance with the Fogg Behaviour Model (see section 3.2.7) which recommends that interventions be timed to "trigger" behaviour, in this case to trigger getting up and going to school.

In both studies, secondary measures of mood, self-esteem, perceived autonomy in school and stage of change were made before and after delivery of the intervention. The stage of change measure was developed as part of this research, adapting existing measures to fit the context of school attendance (see the Truancy Ladder, section 7.2.2.2.4). A measure of Acceptability of the intervention was constructed and taken among participants receiving messages (see section 7.2.2.2.5).

1.4 Findings in brief

It was hypothesised that groups receiving either type of message would attend school more often. In Study One, when messages were sent at the end of the school day this proved to be the case with students receiving the messages missing just 7.7% full days of school compared with those in the control group missing 16%, $p = 0.01$, Cohen's $d = -0.44$ (95% CI -0.74 – -0.14) (see section 7.3.3).

In Study Two, when messages were sent on the following morning to "trigger" attendance as participants prepared to go to school, no significant differences were found between the groups receiving messages and the control group (see section 8.3.3).

It was also hypothesised that the addition of autonomy supporting text to the graphical feedback would further reduce absenteeism. Interestingly this was not confirmed with no significant differences being found between the two messaging groups in either study (see sections 7.3.4 and 8.3.4).

1.5 Contributions to knowledge

The contributions to knowledge that this thesis make can be classed in terms of contributions to theory and contributions to practice.

First, as described above, both the fields of school attendance and text message driven behaviour change are lacking in literature describing theoretically based intervention design and high quality comparative evaluation studies. This research provides contributions of each.

This was, as far as the author is aware, the first study to examine SMS interventions in depth through the lens of Self Determination Theory and findings suggest that graphical feedback alone may be autonomy supporting. It is also the first to examine the use of graphics as the primary communication medium in SMS. While research into the use of SMS to support student attendance has recently been published, it has described the use of SMS in communicating with parents rather than directly with

students. This research is the first to evaluate attendance supports delivered directly to students through SMS.

The impact of timing on feedback has been extensively researched in the context of pedagogical interventions, but little or no such work has been undertaken in the field of behaviour change interventions delivered by SMS. This thesis compares the effect of messages in two very similar randomised controlled trials delivered at different times and finds a substantial difference in effect which suggests that further study is needed in this area.

In post-hoc analysis it was found that the intervention was especially effective among students who came from families where Spanish was the primary language spoken. This is particularly interesting because these students are among the most vulnerable in terms of school absenteeism and dropout (see sections 2.4 and 2.5). Among this sub-population, a difference in response to the two types of messages was found. Those receiving only the graphical feedback reported a significantly more negative mood than either the control group or those receiving the autonomy supporting text. Furthermore, participants receiving both the graphical feedback and autonomy supporting text reported in the acceptability measures that they enjoyed the interventions significantly more than those receiving only the graphical feedback.

Finally, the intervention itself is a contribution to knowledge, being a school attendance intervention that has been proven to be effective and described in detail herein.

1.6 Structure of thesis

The overarching structure of this thesis is illustrated in below in **Error! Reference source not found.**.

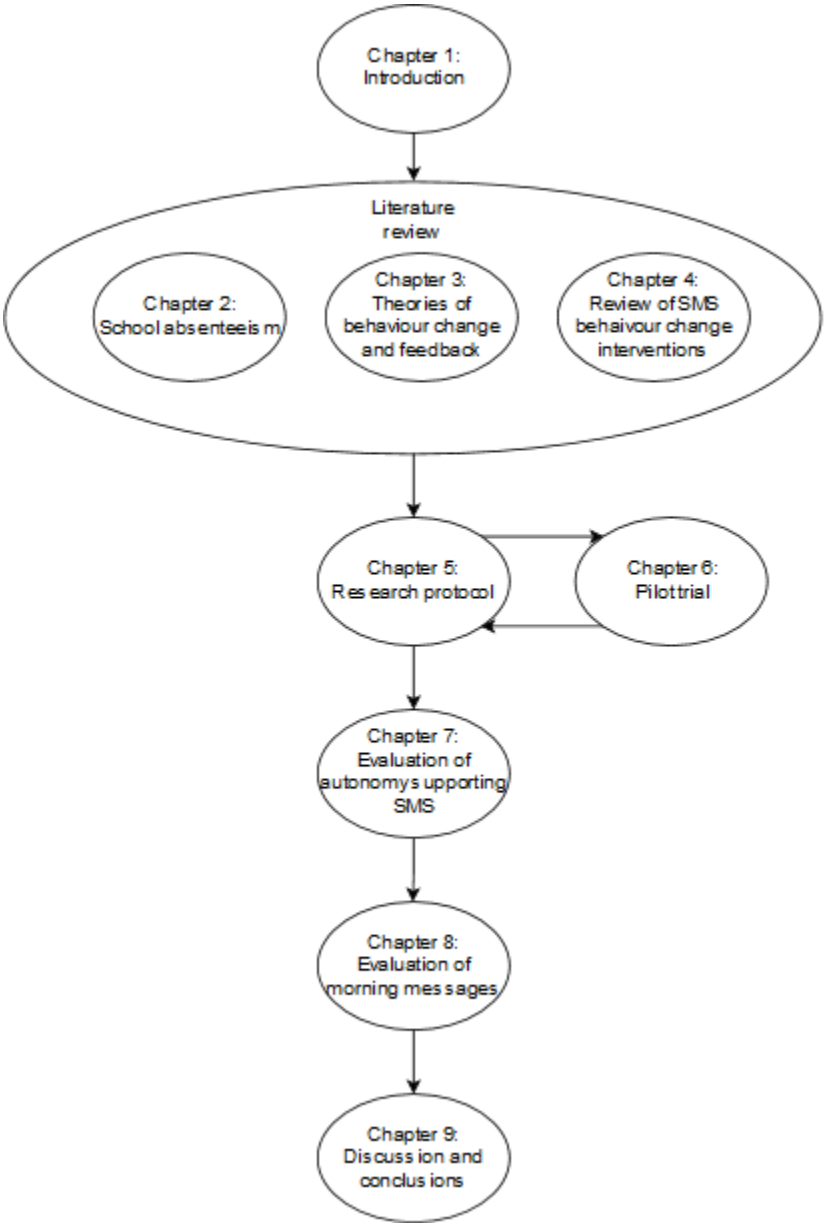

Figure 1: Structure of the thesis

The thesis begins by describing school absenteeism as the context for this research, providing detail of the scale of the issue and then considers what has been learnt from existing evaluations of

interventions to improve school attendance (chapter 2). This is followed by a review of theoretical models that may be used to explain how behaviour change can be influenced in feedback-based interventions targeted at this this issue (chapter 3). Chapter 4 provides a landscape review of computer driven behaviour change interventions

The resulting understanding of the problem context, the theory and the application are combined in chapter 5 which describes the development of the experimental protocol used in a pilot study (chapter 6) and refined for evaluation in chapters 7 and 8.

Finally, the findings are discussed in chapter 9 together with strengths, limitations and contributions that were made to theory and practice. Opportunities for further research are also suggested.

2 School absenteeism

2.1 Introduction

This chapter explores the context in which the research is undertaken, school absenteeism among adolescents. The chapter examines the scale of absenteeism as a problem, the negative effects it has on students, issues of equity surrounding school absenteeism, predictors of absenteeism and interventions that have been evaluated to address it. There is a distinction in types of absenteeism with students missing school by choice ('truancy') or through causes beyond their control such as illness, family relocation, involvement in the criminal justice system, the need to work, or parents that do not encourage and enable school attendance. Because this thesis concerns the effect of feedback on student behaviour this review focusses on *truancy*, absence by student choice as opposed to absence due to illness, mobility or other causes outside a student's immediate control.

2.2 The scale of absenteeism

School absenteeism is a widespread problem around the world. In the US, the average attendance rate for 2011-12 was 93.9% (Digest of Education Statistics, 2015). In England, the absence rate for 2015-16 was 4.6% (Department for Education 2017) while in Sweden, Strand (2014) reports that about 10% of students are truant at least once per month. In Norway, Havik et al (2015a) report that there are no official statistics but 7.5% of their sample of 5,465 students aged 11-15 reported missing more than 13% of school days in the last three months and 6.2% self -reported being truant "quite often". In Holland, 300-400m Euros were spent on dropout prevention between 2007-2012 (Cabus and De Witte 2015). Because this research is based in the USA, the literature reviewed in this thesis will focus on the issue of absenteeism there.

The figures for the USA averages (above) hide a greater problem. While the average attendance rate is above 90%, in the 2013-14 school year, 14% (6.8 million) students in the US were absent for 15 or more days of the school year; nearly half were high school students (3 million high school students - 19%

of high school enrolment) (US Department of Education and Office for Civil Rights 2016). Only 82% of 9th graders graduated within 4 years as expected (Kena et al. 2016). In England, 10.5% of students were classed as "persistent absentees" having missed more than 10% of possible sessions in 2015/16 (Department for Education 2017).

In Texas, where this research takes place, schools are funded according to “Average Daily Attendance”, the number of students attending each day rather than the number of students enrolled. Seven states are funded in this way (California, Illinois, Kentucky, Mississippi, Missouri, New York, and Texas) with other systems including single count days, multiple count days, counts made over periods or based on enrolment rather than attendance. Because the Average Daily Attendance approach cuts school funding when student are absent, even regularly attending students’ school life is affected by absenteeism as well. For example in Austin, the capital city of Texas, an increase in attendance rate by 1% would result in an additional $5.9m of state funding (AISD 2015). With the introduction of the Every Student Succeeds Act (Every Student Succeeds Act 2015), school accountability criteria are being decided by states and there is growing interest in linking school funding with attendance in other states.

2.3 Effects of absenteeism on academic skills

It is generally accepted that missing school harms students’ education, with studies demonstrating correlations between absenteeism and poor reading and mathematics skills in elementary school, disengagement with school in high school, high school dropout and lower completion rates in post-secondary education (Balfanz et al. 2007).

Absenteeism in the early grades correlates with lower reading and math skills (Chang and Romero 2008). Among kindergarten students the strongest correlation with reading and math skills was having more absences (as reported by their teacher), a stronger predictor of success than socio economic status, marital status of parents, race or gender (Gottfried 2011). Moonie et al (2008) found a significant and negative correlation among Missouri students aged 8-17 between number of days missed and state-wide standardized tests in Math, Communication Arts and Science.

Absenteeism also has detrimental effects on students in class who do attend regularly (Gottfried 2011). The effect of peer absences on class performance in reading and math was examined in a study of data from 175 elementary schools between 1995 and 2001 including community census data for each student, demographics, behaviour grades, class schedules and associated teacher data. Gottfried found that students with high rates of absence performed significantly more poorly on reading and math assessments than those with higher attendance rates. Furthermore, even after controlling for individual, class, neighbourhood and teacher characteristics (including the students' own rate of absenteeism), students in classes with a high rate of absence performed more poorly than those in classes with higher rates of attendance.

2.4 Absenteeism and equity

Dating back to the Civil Rights movement, education in the United States is closely tied to the principle of equity and of equal opportunity for all (Civil Rights Act 1964, Hawkins 1991). The distribution of attendance problems across America is far from equal, with localized pockets of chronic attendance disguising the true extent of the problem when viewing the state-wide average figures (Balfanz and Byrnes 2013). For example, the average attendance rate in Rhode Island in 2010-11 was 94% (RIDE InfoWorks n.d.) but of those that attended at least 90 days of the year, 18% were absent for more than 10% of the days they were enrolled. Focusing more narrowly reveals a greater problem, 34% of students in the Providence district of Rhode Island were absent for more than 10% of their school time. Nearly two-thirds (64%) of high school students enrolled in the schools with the highest chronic absenteeism (ranked in the top 10%) missed more than 10% of enrolled days (Balfanz and Byrnes 2012). Chang and Balfanz (2016) found similar patterns with Texas and California reporting an average of 12% of students being chronically absent; however one quarter of those students were enrolled in 1% of districts. This translates to 10% of the chronically absent students in the US being enrolled in just 30 districts in Texas and California.

Several studies have made a connection between poverty and chronic absenteeism (Balfanz and Byrnes 2012, Attwood and Croll 2006, Utah Education Policy Center 2012, Spradlin et al. 2012, Sheldon and Epstein 2004). In a study of absenteeism in Georgia, Florida, Maryland, Nebraska, Oregan and Rhode Island, Balfanz and Byrnes (2012) found that rates of chronic absenteeism were three times higher in middle and high school and twice as high in elementary schools among students receiving free or reduced price lunch. In a UK study, Attwood and Croll (2006) found that truancy levels among students of the lowest socio-economic status (SES) were four times higher than those of the highest SES. A study of absenteeism in Utah found that students receiving free or reduced price lunch were 90% more likely to be chronically absent (Utah Education Policy Center 2012). Spradlin (2012) found that among kindergarten students in Indiana receiving free lunch, 11.21% were chronically absent (missing more than 10%), compared with 3.81% of reduced lunch and 2.4% of those paying for lunch. This divide widened as children got older and in high school 28.6% of students receiving free lunch were chronically absent, compared with 17% of students receiving reduced price lunch and 9% of those paying for lunch. Sheldon and Epstein (2004) found a correlation between chronic absenteeism and low income populations of $r=.375$, $p<.02$ for the year 2000 and $r=.321$, $p<=.05$ for the year 2001 in their study of 29 elementary schools and 10 secondary schools, urban and rural, ranging in size from 135 to 1,753. Similar findings are reported in England where 15.3% of students living in the most deprived areas were found to have missed more than 10% of school days, compared with only 5.3% of those living the least deprived areas (Department for Education 2017).

Students receiving special education services are more likely to be absent and no correlation was found with gender (Balfanz and Byrnes 2012, Utah Education Policy Center 2012, US Department of Education and Office for Civil Rights 2016). Sheldon and Epstein (2004) found that chronic absenteeism was more prevalent in urban schools but Chang and Balfanz (2016) more recently found that many districts with high levels of chronic absenteeism were rural or small towns. Similarly, students from racial

minorities were found to be 40% more likely to be chronically asbent; and those learning English as a second language, 20% more likely to be chronically absent (Utah Education Policy Center 2012).

The effects of absenteeism are not the same for all. Ready (2010) found that elementary students from low SES families make slower progress on literacy than those from wealthier families, however they made greater gains in kindergarten and first grade than their higher SES peers as long as they attended regularly. Absenteeism had a more negative impact on literacy among those from low SES families; the effect was not seen in mathematics skills.

2.5 Predictors of absenteeism

Reid (2003) described four factors that influence non-attendance at school: family related, school-related, community-related and those related to the individual child at the personal level. Figure 2 maps predictors of absenteeism reported in a number of studies in the literature (Corville-Smith et al. 1998, Epstein and Sheldon 2002, Ready 2010, Reid 1982, Vallerand et al. 1997, Wiggs-Stayner et al. 2006).

2.5.1 Family factors

The topic of family factors includes family mobility, particularly in the early years which has been found to correlate with high school dropout. Temple et al (2000) found that the number times that children moved school between grades 4 and 7 significantly correlated to dropping out before completing high school. When children are older, school and personal factors such as disengagement and lack of relationships with teachers become more operational as children have more agency over their attendance and parents have less influence (Ready 2010). Relationships with parents also affect attendance; Corville Smith et al (1998) surveyed students with good attendance and poor attendance and found that parental discipline, control and acceptance all significantly correlated with attendance rates.

Hess (1990) evaluated the effect of parent training in conjunction with contingency contracting and found that the addition of three one hour parent training sessions including structuring home life to enable regular attendance, lesson on discipline without punishment and on avoiding conflicts did not

increase the effectiveness of contingency contracting. Parrish (2015) also evaluated family supports to reduce absenteeism but did not find any significant effect.

Figure 2: Factors in school absenteeism

(Corville-Smith et al. 1998, Epstein and Sheldon 2002, Ready 2010, Reid 1982, Vallerand et al. 1997, Wiggs-Stayner et al. 2006)

2.5.2 School factors

School-related factors include the engaging qualities of the curriculum, relationships with teachers and administrators. In a literature review, Baker et al (2001) recommend changes to school structure based on Self Determination Theory (Deci et al. 1991) that promote student motivation to attend school through more relevant and engaging curriculum, more focus on developing and sustaining student

relationships between each other and with staff and the fostering of self-direction and autonomy. They point to the "relational" model of school organisation (Baker and Bridger 1997) in which relationship building between students and staff and between students is modelled and facilitated.

Many of these factors have been addressed in the school from which participants were recruited (section 6.2.1.1), an alternative high school focussed on dropout recovery where classes are small, students are taught individually, relationship building with teachers is emphasised and students are given a great deal of autonomy, for example to schedule their own learning and pace of study rather than be restricted by a school timetable.

2.5.3 Community factors

Because influencing the community was beyond the reach of a student centred text messages intervention, this thesis does not investigate community factors deeply. Baker (2001) refers to community in this context in terms of the opportunities for students to participate in community activities that make their learning relevant and build the "relatedness" need of Self Determination Theory and so making the school curriculum more engaging. Community expectations around education also contribute to subjective norms that shape behaviour as described in the Theory of Planned Behaviour (see section 3.2.4).

2.5.4 Personal factors

Historically, students missing school were assumed to be at fault. In the 1930s and 1940s, the notion of "school phobia" was introduced (Johnson et al. 1941) this has since broadened into the notion of "school refusal" and is a strong indicator of diagnosis with a psychological condition. (Ek and Eriksson 2013). The psychopathology of school refusal is depression and anxiety with school refusers being 13 (95% CI: 3.4-42) times more likely to be depressed than regular attenders and 8.7 (95% CI: 4.1-19) times more likely to suffer from separation anxiety (Egger et al. 2003). Reid (2003) reported that the personal factors consisted of self-esteem, low academic self-conception and heightened sensitivity to school failure

and Wiggs-Stayner et al (2006) found that flu vaccinations significantly reduced absenteeism in elementary schools.

Havik (2015b) found that self-reported truancy correlated with feelings of social isolation and bullying and students believed that their teachers needed to support peer relationships and prevent the bullying. Corville Smith et al (1998) also found that students' perceptions of self-concept, conflict and social competence significantly correlated with school attendance. Attwood and Croll (2006) found that as well as low income correlating with absences, so did low parent engagement (such as helping with homework), and students' perceptions of the importance of school, bullying and their feelings that the teacher was picking on them. van Breda (2014) also found that students in South Africa ascribed truancy to a poor teacher-student relationships.

According to Self Determination Theory (SDT) (Deci et al. 2001, 1991, Deci and Ryan 2000) (also discussed in section 3.2.5), individuals' are motivated by needs for autonomy, competence and relatedness. Vallerand et al (1997) found that students with a low sense of autonomy at school were more likely to drop out and posited that when students found school to be too controlling, they could fulfil those fundamental needs better outside of school (either in work, in their families or in crime) and dropped out.

2.5.5 Absenteeism is self-reinforcing

The strongest predictor of chronic absenteeism is chronic absenteeism itself (Sheldon and Epstein 2004). If a student is absent for more than 10% of the year, they are 13 times more likely to be similarly absent the following year (Utah Education Policy Center 2012). Several studies have found early school life absenteeism to be a strong predictor of failure to complete high school. The Utah study found that being chronically absent at the start of 8th grade increased the chances of dropout by 7.4 times. 61.3% of students who were chronically absent for four years dropped out. (Utah Education Policy Center 2012).

Balfanz et al (2007) found that they could predict high school dropout with 60% accuracy using four predictors in 6th grade: test scores, indicators of misbehaviour, chronic absenteeism (attending 80% or less) and status variables (special education status, English as a Second Language status, and being one or more years overage their school grade).

2.5.6 Summary

Many of the causes and predictors of absenteeism are facets of institutions like school, communities and families which are beyond the scope of a behaviour change intervention delivered to students by SMS. However, text messages are well suited to addressing personal factors such as self-esteem, students' perceptions of their autonomy, competence and self-efficacy within the context of school attendance as discussed in chapter 4.

2.6 Review of school absenteeism interventions

The reasons that students miss school can be broadly classified as personal, family, school based or community factors (Corville-Smith et al. 1998, Epstein and Sheldon 2002, Ready 2010, Reid 1982, Vallerand et al. 1997, Wiggs-Stayner et al. 2006) as shown in Figure 2. Much of the research addressing school climate and community services requires institutional reform such as changes to the truancy court system (Fantuzzo et al. 2005, Haight et al. 2014, Parrish 2015), linking school attendance with financial benefits (Harris et al. 2001, Riccio et al. 2013), or changing the structure of schools (Baker et al. 2001). This is beyond the scope of this project which focusses instead on individualised support.

However, the setting for this this research is an alternative high school focussed on dropout recovery where many of the school-based factors predicting absenteeism (see section 2.5.2) have been addressed. These include the prioritisation of student-teacher relationship building, maximising student autonomy (for example by allowing them to deviate from their timetables, using student work product for graduation ceremonies and school events, self-paced learning and individualised curriculum). As a result,

this research is able to look beyond the school-wide interventions that focus on factors of attendance support at the individual level.

In order to fully scope the review a keyword search was made of the Academic Search Complete, ERIC, SCOPUS, Medline, Proquest and PsychInfo databases using the following search term "(Attendance OR Absence) AND (Evaluation OR Intervention OR Treatment OR Outcome OR Program) AND (Truancy OR School refusal OR Absence OR Attendance OR School phobia OR School anxiety OR Dropout OR Expulsion OR Suspension)". Additional searches were undertaken on Google Scholar and through other secondary sources such as Attendance Works[1]. Additional sources were found through the references in publications reviewed. Interventions involving school-wide structural change, after-school programs, community based programmes, punishment and payment for attendance were excluded. The focus for inclusion was delivery of supports to students on an individual basis.

The purpose of the review was to examine the methods and effectiveness of school attendance interventions with a view to identifying features that could be delivered by text messages. First a review of other reviews is presented. This is followed by a short review of three classes of attendance intervention: Mentoring and Case Management, Contingency Contracting and Rewards, and Data Driven Interventions.

2.6.1 Review of Reviews

Most reviews of attendance intervention literature have mentioned the scarcity of high quality research (Sutphen et al. 2010, Maynard et al. 2013, Klima et al. 2009). For example Sutphen et al (2010) searched literature between 1990 and 2007 and found only 16 studies, only 8 of which used a group comparison experimental design.

[1] http://www.attendanceworks.org/research/

Sutphen et al (2010) classified interventions as small scale Student and Family-Based that social workers could implement with individuals or groups of students, and large scale School-Based and Community-Based interventions that required more structural changes. They were unable to make any recommendations.

Ektrand's review (2015), identifies a broad range of 155 research report focussed on larger scale interventions like prosecution, mentoring, schoolwide programs and alternative curricula, community partnerships, organizational changes in school and local government, changing school culture and addressing students' academic needs but does not include any of the student level interventions described below. The review concludes that in order to address truancy we should focus not on the individual student's shortcomings in attendance but instead on changing the school climate to provide a positive setting where relationships with teachers, staff and fellow pupils are positive and lead to more positive school experiences.

In Klima et al's review of truancy interventions (2009), they found that only 22 studies met their criteria for rigor. They classified interventions as academic remediation, career information, case management, contingency management, counselling, mentoring/advocacy, monitoring, parent outreach, youth development and additional services like parenting classes or health centres. Overall, they found that school-within-a-school programs, mentoring and case management and contingency management programs had a positive effect on attendance while youth development programs, academic remediation and separate alternative campuses had no effect.

The Campbell Report by Maynard et al (2012) focused on interventions aimed at improving school attendance among students with attendance problems, rather than general school populations. They included only studies of school age students in US, UK Canada and Australia published between 1990 and 2009 where the outcome variable was school attendance and they excluded any studies that did not report quantitative data that could be used to calculate an effect size. They identified only five randomised controlled trials, 11 quasi-experimental studies and 12 single group pre-test/post-test studies that met their

search criteria. These covered a wide range of intervention types, including court-based interventions, academic tutoring, contingency contracting, mentoring, and therapy. They found that the mean effect size of interventions was 0.46 ($p < 0.05$) but were unable to identify any common themes that predicted effectiveness. They made a number of suggestions for future research to improve quality (which they found lacking) and to fill gaps. These included: use of random assignment to comparison groups, full demographic reporting, reducing attrition, clear reporting of absenteeism data, inclusion of students from racial minorities, cost benefit analysis and clear descriptions of intervention implementation. The research described in this thesis has been designed to address those recommendations.

Whilst not a review of existing literature, the findings of Sheldon and Epstein's (2004) research is included here as they document the effectiveness (as perceived by school staff) of attendance interventions being implemented in a sample of 39 schools (29 elementary, 10 secondary) and their effects on chronic attendance rates, when controlling for the previous year chronic attendance rate. Previous year chronic attendance rate was the strongest predictor of subsequent chronic attendance rate. When comparing rates of chronic attendance while implementing different types of intervention, the number of communication activities (parent orientations regarding attendance, newsletters listing students with excellent attendance, giving parents the name and telephone number of a person at school to talk to about attendance, and providing parents with online access to their child's attendance data) was found to have the greatest significant effect on chronic attendance rates

In summary, the combined outcome of these reviews is unclear. They suggest that there is evidence that absenteeism can be reduced by school based interventions but there is little high quality research from which to draw conclusions. Themes that emerge as being effective are communication of information with families, mentoring and case management.

2.6.2 Mentoring and case management

A number of studies have investigated the impact of mentoring or intensive case management on students with a high number of absences. These are often very intensive interventions and results show limited effect.

In a randomised controlled trial (RCT), De Socio et al (2007) supported high school students who had been absent for more than 15 days in the previous year (n=66) with teacher mentors who checked in with students several times a week, offered grant money for extra curriculum project (such as art work), advocated for the students and coordinated with parents to solve attendance problems. Treated students were enrolled in the school health centre with an intake interview, health questionnaire, examination and follow-up. Psychiatric nurse practitioner hours were also extended for participants' access. Students in the intervention group were significantly more likely to remain in school, rather than drop out, than those in the no treatment control. Students receiving the intervention were absent less than those in the no treatment control and those students that did not were unable to enrol fully for the treatment condition. Attendance in this trial was measured in terms of the minimum and maximum number of days that a student missed a particular class.

Cabus and DeWitte (2015) assessed the effect of home visits and increased awareness of attendance issues and dropout prevention among teachers in a quasi-experimental difference in differences analysis involving 1345 home visits and an average time investment of 5 hours per student. They found that dropout at the intervention schools was reduced by 0.54% compared with control schools and by 1.4% among the students in the lowest ability track.

In a quasi-experimental study, Fantuzzo et al (2005) evaluated the effect of moving truancy court into school buildings and including social services with traditional truancy court and a no court referral group. Students were matched by gender, age-group, ethnicity and standard baseline rate of unexcused absences. They found that both court groups reduced absences for 30 days but the effect of traditional court group started to fade within 60 days while the community based court effect was retained. After a

year, the traditional court group were absent for the same number of days as the no court control group but the community court group that were given access to additional services still had significantly fewer absences.

In a PhD thesis, Parrish (2015) compared the outcomes of students who were diverted from truancy court into a program of family counselling and case management with those that continued in the truancy court system. Diversion was at the discretion of the court services intake worker but students could not be selected for diversion if they had been previously diverted, had criminal charges pending or a history of adjudicated charges. No differences between the groups were found in unexcused absences, discipline referrals or grades but surveys revealed that school factors such as safety, teacher/student relationships and teacher expectations were the primary drivers of non-attendance rather than the family factors hypothesized by the researcher and addressed by family counselling in the treatment.

In a small randomised controlled trial (N=32) Converse and Lignugaris/Kraft (2009) evaluated the effect of weekly mentoring classes for middle school students with 3 or more office referrals and 7 or more unexcused absences in the previous school quarter. No effect was found on attendance but mentored students had fewer discipline referrals during the intervention.

Haight et al (2014) evaluated an intervention comprising a weekly mock court of a judge, parents, CASA worker (court appointed special advocate), school administrator and community social worker to review attendance, discuss barriers to attendance and to make tutoring and other services available. Student levels of internalizing behaviours (anxiety, social phobias and depression) and externalizing behaviours (oppositional, hyperactive-impulsive, attention deficit hyperactivity disorder and cognitive-attention problems) declined over the course of the intervention but attendance was not measured.

Bynum et al (2004) evaluated the effect of an increasingly intensive intervention comprising attendance letters, visits from attendance officers, referrals to social services and eventually to the police. They compared attendance before and after each intervention and students only progressed to the next level of intervention if their attendance did not improve. They found significant reductions in attendance

among those students classed as chronically absent (20%+ absences) after letters were sent and after visits from attendance officers. The number of students referred to social services or the police was very low and there was no associated significant difference in attendance pre and post intervention.

Newsome (2004) evaluated the effect of solution-focused brief therapy (SFBT) in a quasi-experimental study wherein a therapist asked students what they wanted to achieve in the 8 week period, how they rated themselves, what score they'd like to give themselves at the end of the semester, what they thought signs of success would be, what advice they'd give their younger self when they're old and a review of how they have changed. These lessons were covered in 8 weekly, 35 minute class periods in a group setting. Students were recruited from a list of 7th and 8th grade students judged to be performing at a below average academic level or chronically absent or having low attendance in the previous year and were not receiving special education services (N=52). Students were assigned to either the SFBT group or a no treatment control group. No significant difference was found in attendance levels.

These interventions that attempt to case manage or mentor students and families had mixed effectiveness but all were very intensive and required considerable staffing resources to implement. None publish the cost of the intervention and only Cabus and DeWitte (2015) offer concrete indications of the resources needed (five hours per student to reduce dropout by 0.54%). Some were found to be effective at reducing absenteeism (Bynum et al. 2004, Cabus and De Witte 2015, Fantuzzo et al. 2005) but only the Cabus and DeWitte (2015) offers a clear comparison, albeit not with a randomly selected control group.

2.6.3 Contingency contracts and rewards

The interventions described above detail group counselling, case management and school-wide financial incentive programs. More focused interventions that place more accountability on the individual student can be implemented with contingency contracting which involve a student drawing up a contract to attend school at a certain rate for a set period with rewards given to them upon success.

In this review, studies which include behaviour contracts are found to be similar to the group counselling interventions above, with groups of students meeting to review their performance weekly (Hess et al. 1990, Hess 1990, Herrick 1992, Tichenor 1991). A second class of interventions will be reviewed in this section, those in which no specific goal is set, but students are rewarded in proportion to their attendance. Most of these interventions require the students themselves to keep track of their own attendance through signature sheets or punch cards (Brooks 1975, Cole 2011, Ford, J. and Sutphen 1996, Licht et al. 1991, Zweig et al. 1979, Flanagan 2006).

In Hess' dissertation (1990), 42 middle school students receiving special education services were assigned to either a no treatment control group, a contingency contracting group or a contingency contract with parent training group by way of a matching groups approach assigning students to groups so that each group had matching attendance rates of weekly truancy. Each week, students in the experimental groups met to review their previous week's attendance, were rewarded if they had met their contracted goals, or explained why they had not met their goals and wrote a contract for the following week. Parent training took place in 3 one-hour sessions (12 out of 30 parent attended) included use of positive parent messages, using rules, limits and consequences and also included snacks and non-contingent prizes. After 5 weeks, both treatment groups had similar positive effects on attendance but neither continued after the intervention ended.

Herrick's (1992) quasi-experimental study (N=49) compared attendance rates of elementary students with another group (N=15) of students at a second school for a year. Students contracted to attend for five days in a row and if they were successful, were awarded prizes and given a ten day target. If they were not successful, they continued with a five day target. No significant difference in attendance was found between the groups.

In a randomised controlled trial (RCT) of 26 middle school students receiving special education services with high levels of truancy, Hess et al (1990) compared the effectiveness of contingency contracting and group counselling with a no treatment control. Again, the experimental group showed a

significant reduction in truancy during the intervention (from 1.83 to 0.89 days per week in the treatment group compared with 2.17 to 1.88 days per week in the control group) that did not continue once the intervention ended.

While these interventions were focused on goal setting and reflection with weekly meetings, others used a more implicit goal - to come to school as much as possible and rewarded students proportionately to the their attendance (Cole 2011, Brooks 1975, Ford, J. and Sutphen 1996, Licht et al. 1991, Zweig et al. 1979, Flanagan 2006).

Tichenor (1991) used weekly meetings to review attendance (which was monitored by the researcher rather than the students) and to contract with students but did not tie rewards to the contracts, instead giving praise and public recognition when students were successful and asking those that did not have perfect attendance to explain why not. No difference in attendance behaviour was found when compared to a pseudo-control group of students data selected with the same criteria from the same grade level two year previous.

Licht et al (1991) tracked attendance for students for 12 weeks, sharing their performance, recorded at class period level, once a week when students were awarded points for their behaviour and given the choice to exchange them for fast food coupons, movie tickets, clothes or school supplies or to carry them over to the following week. A group contingency (all members achieving 97% attendance) was added in the 6th week and removed after 3 weeks because of its discouraging effect on the students. In the 5th week of treatment, the researchers started calling parents to let them know when their children were absent. Twenty students with special education needs aged 14-17 participated in the study and were assigned to treatment groups by pairing students with similar baseline attendance rates and randomly assigning each member of the pair to a treatment group. Attendance in the treatment group was consistent across the intervention period but attendance rates of students in the control fell.

In an RCT of high school students with nine or more days of truancy during the first eight weeks of the year, Brooks (1975) required students receiving the treatment condition to collect signatures from

the teacher of each class that they attended on a card. They could then exchange the card for tickets for drawing of cash, movie tickets, music albums and gift certificates. Students in the treatment group showed a significant reduction in truant days in the 8 weeks of intervention when compared to the first 8 weeks of school (from 22.3 days to 7.1 days. $p<.001$) while the control group increased from 21.9 days to 29.3.

In a small pre/post intervention study (n=10), Cole (2011) found that elementary school students with more than seven absences in the first semester who checked daily to punch a card to track their attendance and could later exchange the card for rewards (pens, pencils, pencil sharpeners etc) were absent for fewer days (from 8.8 absences to 1.7 absences over the six weeks)

As part of a whole school attendance project, Ford and Sutphen (1996) applied the Positive Behaviour Interventions and Supports (PBIS) program. PBIS takes a tiered approach to interventions, with easily scaled interventions applied at the school level (Positive Behavioral Interventions & Supports 2017) - in this case posters announcements about the importance of regular attendance and public recognition of students with a good attendance record. In addition, focused interventions are provided for students who are not successful. A focused attendance intervention was administered to nine students who had been absent for more than 20 days in the previous year. The intervention had both school based and home-based components. At school, students were given a sticker chart to track their attendance, tokens based on their attendance that they could exchange for rewards and counselling. At home, school staff made home visits to counsel parents on ways to be more engaged with their children's school work and to problem solve attendance issues like transportation. No significant difference in attendance was found at the school wide level (compared with the previous year) or in the more focused group intervention (when compared to students' baseline attendance).

Zweig et al (1979) award a student trading stamps for attendance which they could exchange for goods from a catalogue in a single student reverse design case study. The student attended school with

almost a perfect record while the intervention was in place but returned to their previous levels of absenteeism as soon as it was withdrawn.

Flanagan (2006) examined the effectiveness of teachers praising consistently attending students and signing a check-in card which students could exchange for tangible rewards such as gift certificates. The study took place over a full school year as a comparison of groups study (albeit with the intervention group, N=32, being self-selecting and the control group recruited at the end of the study for the purpose of comparison only). The intervention group was found to show an increase in attendance and grades over the year while the comparison group showed a decrease ($p<0.01$) despite a low level of intervention (average number of reinforcements 8.19 per student, SD=6.4).

Contracting, goals and reflection are the foundation of many interventions based around social cognitive theory/self-efficacy but in the experiments above, which all track attendance, there does not appear to be a benefit to setting explicit goals. This could simply be because students, even those who are regularly truant, often know that they *should* go to school and so there is already an implicit goal that students can work towards without teachers imposing an explicit goal on them (even if it's a goal of their own choosing). In the discussion of self-monitoring as a part of Social Cognitive Theory, Bandura (1991) addresses the variability of the effectiveness of goal setting on behaviour change noting that that it can be explained by the level of self-directedness; goal setting is effective when one sets one's own goals with autonomy but may not be when goals are more a product of an intervention requirement. Self Determination Theory (Deci et al. 1991) supports this notion that imposing goals on people may be perceived as controlling and reduce feelings of autonomy, and in turn, reduce intrinsic motivation.

2.6.4 Data driven interventions

Recently, researchers have used data held in school databases to reach out to students' families in more individualised and scalable interventions, with such interventions showing promise. For example, Rogers and Feller (2018) describe a randomised controlled trial in which they sent families of students five letters over the course of the year with information about their children's school attendance. They

found that sending parents information about the number of days that their child had missed school significantly reduced absences by 1.1 days per year ($p<.001$) when compared to a no treatment control. Sending information to parents about how their children's attendance compared with their peers did not significantly change their attendance. The intervention cost $6.60 per household per year to deliver. Similarly, Bergman and Chan (2017) sent weekly SMS messages to parents detailing missing class assignments and the number of days that their child was absent and found that students attended 18% more class periods than the no treatment control. The authors estimate a cost of $7/child to deliver the intervention for a year.

These studies suggest that sending individualised information to students and their families can change behaviour in large numbers and at low cost. They offer little detail in terms of theoretical foundation or investigation of message components but suggest that school attendance is a behaviour that can be changed through interventions delivered in the form of text rather than in person in the same way as many of the SMS interventions described in chapter 4.

2.6.5 Measurement of attendance

The literature is not clear on how previous interventions calculate attendance rates. In particular, there is little discrimination between full and part day attendance, only that the school's determination of attendance is used (Converse and Lingnugaris/Kraft 2009, Tichenor 1991). Hess (1990) states that the roll-book was "updated daily". Attendance rates are often reported as a percentage of days absent during a period (Brooks 1975, Newsome 2004, Reid and Bailey-Dempsey 1995).

Some studies have provided more detail of their attendance measures: Parrish (2015) defines an unexcused absence as missing "all or part" of a day without permission; Zweig et al (1979) as not being present in home room by morning roll call. Fantuzzo et al (2005) measured the number of unexcused absences in 30 day period as a proportion of the number of school days in a trial period but made no mention of partial day attendance. Flanagan (2006) measured missed classes as the number of days that

students were marked absent all day multiplied by 7 periods plus the number of classes they missed when marked present at school plus the number of days that they were late for school multiplied by one half. Daily cuts were measured as the total number missed classes when marked present in school as a proportion of the number of days in the semester. Licht et al (1991) measured the number of classes missed as a percentage of classes in which the student was enrolled.

These observations support the recommendation from Maynard et al (2013) that studies include clearer measurement of attendance.

2.7 Summary of findings

This chapter has shown that school absenteeism is a substantial problem around the world with pockets of high severity, particularly among low socio-economic groups (see section 2.4) and that absenteeism harms student achievement (see section 2.3). While school absenteeism is a complex problem, with many influential environmental factors (such as family, school and community factors) that are beyond the effect of an intervention operating through individually targeted feedback messages, there is also a personal dimension to absenteeism predictors. This dimension includes factors of self-efficacy, self-esteem, perceptions of autonomy and mood.

For the most part, it is difficult to draw conclusions from the interventions reviewed as their methodologies are varied and sometimes lack rigour, they do not clearly describe how they measure attendance and sample sizes are often very small. Many of the studies appear to focus on building participant self-efficacy through programs of performance monitoring and through developing self-esteem through improved relationships and counselling but no specific mention is made of any theoretical foundations.

The more recent studies (Bergman and Chan 2017, Rogers and Feller 2018), published after this research was undertaken, show a new direction in research based on data driven interventions using attendance record systems to provide families with information on their children's attendance. These

studies have shown positive effects at lower cost and greater scale than earlier interventions even though they lack the personal contact on which earlier studies were focussed. That these automated interventions have been found effective suggests that that the goals of this research, to deliver attendance supports directly to students by SMS, may also be effective.

3 Theories of behaviour change and feedback

3.1 Introduction

The primary goal of this research was to examine components of feedback that could change behaviour when delivered to participants' cell phones by SMS.

Chapter 2 examined the factors that influence school absenteeism focussing on the personal factors that could be addressed and identified self-esteem, self-efficacy and perceived autonomy as targets for support. This chapter reviews the research surrounding computer driven feedback and behaviour change interventions in both educational settings and outside the classroom with aim of providing guidance for the design of the intervention.

3.2 Theories of behavioural change

3.2.1 Theories of Feedback

Feedback in the educational setting has been most researched in its use as an instructional tool; from traditional assignment grading by teachers, to the Skinner learning machines (Skinner 1958) which gave immediate feedback, to intelligent tutoring systems that continually assess student understanding of a topic and deliver immediate feedback tailored to individual students' misconceptions (Millán et al. 2010). Research has been undertaken to pick apart the characteristics of feedback that predict the highest effect on performance including timing (immediate or delayed), specificity (verification if the answer is correct compared with advice on improving the answer), the length and complexity of the feedback, the use of comparisons to class norm performance (Kluger and DeNisi 1996), the tone of the message (a personal tone or a more computer like tone) (Moreno and Mayer 2000, 2004) and the context in which the feedback is given. Many of these studies are examined in Shute's review of formative feedback (2008).

While the roots of feedback research in instructional settings appear to have been in the school of behaviourists like Skinner, simple reinforcement of learning by indicating whether an answer is correct

does not, in itself, lead a student to answer correctly more often (Kulhavy 1977). Instead, the effectiveness of feedback appears to be a function of the context in which it is given. In a meta-analysis of more than 600 feedback studies, Kluger and DeNisi (1996) proposed and evaluated a Feedback Intervention Theory (FIT). Their model posits that our behaviour is regulated by comparisons we make of feedback on performance with a set of standards that we organise hierarchically from basic low-level tasks (like "reading words") to standards for the "self" (like "investing in my science career"). The theory states that we tend to direct our attention to mid-level goals rather than the "big picture" or the task-performance level steps of an activity and because we have limited cognitive bandwidth, can only direct our attention (and so our capacity to change behaviour) to one goal at a time. FIT therefore suggests that behaviour change effects are a function of shifting attention to other relevant aspects of the task at hand rather than the feedback itself.

3.2.2 Social Cognitive Theory

Social Cognitive Theory (SCT) (Bandura 1977, 2001, 2011) identifies self-efficacy as a predictor of behaviour and recommends experiences of "performance accomplishments, vicarious experience, verbal persuasion and physiological state" to boost self-efficacy which causes behaviour change. Feedback can be used both to draw attention to performance accomplishments, encourage reflection on performance and to persuade participants to attempt to perform tasks that they may not otherwise attempt (Hermsen et al. 2016). In a review of studies in increasing physical activity by targeting self-efficacy, providing feedback was found to be the most effective method of intervention (Ashford et al. 2010).

Perceptions of self-efficacy are constructed through self-regulation which is described as a combination of self-monitoring, self-judgement and self-reaction (Bandura 1991). Together, these components form the system that drives self-motivation to improve personal performance and ability. A key aspect to self-regulation is that people may believe ability to be an innate quality that they are born with or may see it as an acquirable trait which can be developed and improved. Where a person sees the ability as a personal trait they are more likely to set easily achievable goals, see failure as personal

inadequacy, avoid effort because they see it as a sign of weakness and respond to the success of others as a negative judgement of themselves. Conversely, a person who sees ability as acquirable will set challenging goals, see failure as a sign that they did not work hard enough and learn from mistakes. This may become a reinforcing feedback loop with success breeding success or failure reinforcing self-perceptions of inability. In behaviour change interventions, the positive effects of this feedback loop can be supported by goal setting, performance feedback and self-reflection (Franklin et al. 2003, Hatchett et al. 2013, Shapiro et al. 2008).

3.2.3 The Transtheoretical Model

Another commonly cited theory in the design of behaviour change interventions is the Transtheoretical Model, which also provides helpful direction for design. The Transtheoretical Model (TM) describes five stages that a person making a change to their behaviour goes through: Pre-contemplation, Contemplation, Preparation, Action and Maintenance (Prochaska et al. 2008, Norcross et al. 2011). As they progress through these stages, different interventions are most suitable. In the early stages of Pre-contemplation, Contemplation and Preparation, when subjects are moving from not thinking about changing to preparing themselves to change, cognitive and motivational treatments are most useful to help them to commit to making a change; but during Action and Maintenance, behavioural-based interventions are more beneficial to help with making the change itself. For example, in a smoking cessation intervention, feedback for participants who have not yet chosen to give up smoking would be focused on helping them to make that choice. Feedback for participants who have not smoked for several weeks would be focused more on the benefits that they are already enjoying and on tips for avoiding situations in which they want to smoke (Haug et al. 2009).

3.2.4 The Theory of Planned Behaviour

The Theory of Planned Behaviour (TPB) (Ajzen 2011, 1991) is often cited in behaviour change interventions but does not make clear recommendations on how to change behaviour. Instead TPB can best be described as a predictor of behaviour and is used by behaviour change intervention designers to

focus on behavioural determinants to modify which will, in turn, modify behaviour. TPB builds on the earlier theory of reasoned action (Fishbein and Ajzen 1975) which posited that all behaviours were the result of a person's intention to act which in turn stemmed from their attitudes towards the behaviour and social pressure to perform the behaviour or not (Ajzen and Madden 1986). The TPB modulated that single cause of intention with a person's *self-perceived behavioural control* because while intention is obviously necessary for purposive behaviour, without the necessary ability it cannot be actioned. They focussed on perceived behavioural control rather than actual behavioural control because it is both more easily measured, and actual control may depend on unlimited and unpredictable factors. This aspect of TPB is similar to SCT in that perceived behavioural control is a similar concept to self-efficacy and can be manipulated in the same ways. Ajzen later clarified the concept of perceived behavioural control as being a combination of *perceived self-efficacy* (being the perceived easy or difficulty of the behaviour) and *controllability* (being the extent to which individuals believed that performing the behaviour was up to them) (Ajzen 2002).

TPB can be applied to SMS driven behaviour change interventions to change beliefs surrounding the importance of performing the behaviour and to communicate social norms by delivering information, or to support self-efficacy and participants' perception of agency (controllability) in performing a behaviour with performance monitoring and feedback.

3.2.5 Self-Determination Theory

Self Determination Theory (SDT) is a theory of motivation that has been applied to enhancing students' engagement with school generally (Deci et al. 2001, Deci and Ryan 2000, Soenens et al. 2012, Vansteenkiste et al. 2006) and specifically to the engagement of students classified "at-risk" of dropping out of school (Baker et al. 2001, Bry and George 1980, Vallerand et al. 1997). SDT posits that motivation is rooted in a person's need for autonomy, competence and relatedness. "Autonomy" references a sense of choice in performing a task, performing it for one's own sake rather than because someone or some institution requires or expects it. The Organismic Integration Theory is one component of SDT and

describes a continuum of motivation in terms of the level of autonomy experienced by a person. This ranges from "external regulation" in the form of rewards and punishments; through "identification", a stage at which motivation cannot quite be said to be intrinsic (performing a behaviour simply because one wants to) but performing a behaviour because one accepts that it is beneficial to one's one aspirations to do so; finally to "intrinsic" motivation when the person acts purely for the sake of performing the task. "Competence" refers to sense of becoming skilled or knowledgeable in the task, of being challenged and the reinforcement of meeting a new challenge. "Relatedness" describes the context within which the task fits – how it relates to friends, community and the wider world.

SDT raises concerns about traditional behaviourist reinforcement of student performance with tangible rewards because they focus the driver of task performance away from autonomous self-direction and the students' need for autonomy, competence and relatedness onto the reward, an external actor (Deci et al. 2001). Unlike theories of behaviour change, SDT does not aim to enforce a behaviour upon a person, but instead to provide the supports that will enable a person to adopt a behaviour that they find enriching. Indeed, interventions that impose the view of others, such as with deadlines, performance goals, competition or rewards (both contingent and non-contingent) have been found to reduce intrinsic motivation (Deci et al. 1991).

Tangible rewards are found to undermine or at best have no effect on intrinsic motivation (Deci et al. 2001) whether awarded non-contingently or contingent upon engagement with a task, completion of a task, or upon success at a task. In the case of non-contingent rewards, no reinforcement of competence or autonomy is given because no effort is required. Where mere engagement is being reinforced, little autonomy and no competence is being reinforced. In the case of completion rewards, autonomy has been further eroded as students were required to do more work for their reward. Where only success is rewarded, there is even greater loss of self-determination – not only must a student attempt a task but they must also reach a minimum standard set by the teacher.

As seen in section 2.5, SDT has been used to examine school absenteeism, particularly the facets of student autonomy and relatedness and usually in terms of school environment. SDT raises concerns that rewarding participants for meeting standards reduces their perceived autonomy and in turn, their intrinsic motivation. In the general context of school attendance, there is little autonomy; students are expected to go to school every day and if they fail to do so, they may face punishment. Many of the interventions described in section 2.6 applied contingent rewards (which can reduce intrinsic motivation according to SDT) but also included information and counselling which could help students to make the goal of school attendance their own and so counter that effect.

3.2.6 Motivational Interviewing

Motivational Interviewing (MI) is more of a framework describing a method of therapy that is successful than a ground-up theory. MI is based in part in Rogerian person centred therapy and practices the same "unconditional acceptance" but is more goal driven and directional, albeit with a very light touch (Resnicow and McMaster 2012). Its practice is to reflect on what the client says without judgement, suggest new ways of thinking and help the client to choose to make choices to change their behaviour. MI led to a 61% reduction in truancy when used to address truancy (Enea and Dafinoiu 2009) in group therapy sessions while the no treatment control showed no reduction. While causation cannot be inferred as there was no random assignment to groups, this first controlled study suggests some effectiveness of the technique.

3.2.7 Persuasive Technology Theory

Captology is the study of computers as social actors and persuasive agents. Facets that enable persuasion include physical attractiveness, similarity and affiliation, the use of appropriate language and praise in interactions, social reciprocity and adoption of social roles such as being authoritative (Fogg 2002).

Fogg's Behavioural Model (Fogg 2009) appears to build on the Theory of Planned Behaviour (section 3.2.4 above) but does not claim to do so. The model is based on three prerequisites to persuade people to perform a behaviour: Motivation, Ability and a Trigger. All three are needed, for example, if a person lacks motivation or ability, a trigger is merely annoying or causes frustration. Fogg describes three types of motivator: pleasure/pain, hope/fear, and social acceptance/rejection; and six factors that affect the ability of a person to perform a behaviour: time, money, physical effort, brain cycles, social deviance and whether or not it is a routine behaviour.

He suggests three types of trigger. First, the "Sparks as trigger" combines a call to action with one of the motivators listed above to prompt a person lacking motivation, for example "Act now or…" in combination with a fear motivator. Secondly, the "Facilitator as trigger" that can help a person lacking ability to act by combining a support to one of the factors affecting ability listed above. Finally, a "Signal as trigger" can be given when the subject already has both motivation and ability and simply needs a prompt. This notion of a trigger suggests that the timing of feedback may be important. While timing of feedback has been researched quite extensively in the context of computer driven tutoring systems with conflicting conclusions (Shute 2008), little research has assessed the impact of timing in SMS driven behaviour change interventions (see chapter 4).

3.2.8 Scarcity Theory

Mullainathan and Shafir's theory of scarcity (2013) describes how a shortage of money or time can capture the mind, making people effective at managing the highly focused tasks involved in survival but doing so at the expense of neglecting the rest of their obligations which in turn leads to further scarcity. Their theory centres on two constructs, that of "bandwidth" and "tunnelling".

Bandwidth is the amount of cognitive processing power available to people. Through a series of experiments the authors demonstrate that in cases where people are living with a shortage of time or money, their cognitive ability is reduced. Bandwidth encompasses cognitive capacity and executive

function; a reduction of cognitive capacity is reflected in a reduction of fluid intelligence or problem solving ability and reduced executive function leaves people with less self-control.

Tunnelling is what everyone does to some extent when they focus on an urgent problem, they pay attention to the task at hand and tune out distractions. As a result, they can work very effectively on the task that is the centre of focus. When a person is dealing with scarcity, whether it be a lack of time or of money, they must focus on immediate problems such as meeting the next deadline, paying the most urgent bill, pushing back other deadlines or avoiding creditors. All else must wait. While everyone has times when they need to focus on an urgent task, those living with chronic scarcity are in a perpetual state of tunnelling. As a result, their lives fall further out of control and the scarcity becomes self-reinforcing.

The authors posit that the effect of poverty on people is a continuous reduction of cognitive ability which makes it difficult to study, learn or remember to take care of important day to day tasks and of executive function that leads to less self-control. Poverty reduces the cognitive bandwidth that people have available to them and focuses those reduced resources on getting through the day and dealing with problems that are immediate; there are no resources left for planning for the future or improving the state of their lives (Mani et al. 2013, Shah et al. 2012).

If we accept that the poor are narrowly focusing all of their already reduced cognitive bandwidth on managing their short term financial position, it is not surprising that educating them on the dangers of payday loans or the need to take medication or the process of applying to college is not effective. It's not immediately important enough to attract attention from inside their tunnelled attention. If we are to change their behaviours, we must position our message inside the tunnel to capture their attention afresh each time we interact. This raises the possibility that text messages, which by their nature, capture one's attention may be effective.

In Jennifer Pahlka's lecture about Code for America, she describes a problem in the California food stamp program (Pahlka 2015, Jacobs 2014). Once participants were enrolled, they often lost their benefits and had to reapply. Her program found that participants were not responding to letters that told

them to return additional documents because they went unnoticed among other letters that did not require a response and were difficult to read. When they were sent text messages warning that their benefits were going to end, forty percent of recipients responded and so avoided being removed from the program. This use of text messages applies Mullainathan and Shafir's theory by placing the notification in the participant's "tunnel" where they find it is harder to ignore than a letter.

3.2.9 Theories applied to school absenteeism

There is not a large body of research connecting observations of absenteeism with theoretical foundations. Huck (2011) applied Social Disorganization Theory and Deterrence Theory and examined the community and environmental effects on school attendance of Hurricane Katrina. Davis et al (2002) examined school dropout through the lens of the Theory of Planned Behaviour (Ajzen 1991) and noted that student intentions to graduate and perceptions of their own control over their behaviours were the strongest predictor of graduation. Vallerand et al (1997) found that students with a low sense of autonomy at school were more likely to drop out if they found school to be too controlling and could fulfil their needs for autonomy, competence and relatedness better by dropping out. Baker et al (2001) explored changes to school structure based on SDT to increase student motivation and reduce school dropout. These findings suggest that providing students with feedback on their attendance may fulfil needs for competence and perceived behavioural control by creating opportunity for reflection and self-regulation.

Reviewing the "personal factors" associated with absenteeism in Figure 2 (section 2.5), a person with experience teaching youth with poor attendance would not be surprised to see self-esteem, academic self-concept, anxiety and social competence listed as factors. These are facets of young people that teachers regularly support through praising correct behaviour. Bandura's (1977) Social Cognitive Theory describes how self-reflection on task performance can boost perceptions of self-efficacy which in turn increases the effort that individuals are willing to expend on achieving a task. Teachers often help students to reflect on their performance to help them to increase their perceived self-efficacy, confidence, self-esteem and achievement.

3.3 Summary of findings

This chapter set out to describe the theoretical frameworks that would guide development of an intervention to support participants' self-esteem, self-efficacy and perceived autonomy in school in a similar way as the absenteeism interventions that tracked attendance and provided counselling described in chapter 2.

Several theories offer ways to conceptualise supporting students to increase their attendance. Tracking and reflecting on performance can build self-efficacy according to Social Cognitive Theory (section 3.2.2) which often also incorporates goal setting. The Theory of Planned Behaviour (section 3.2.4) also recognises that changing a person's perception of their level of control over their behaviour predicts the likelihood that they will change. The concept of mastery, one of the three pillars of Self Determination Theory (section 3.2.5) is supported by performance tracking, though it suggests that both praise and rewards may harm perceived autonomy, a second component of the theory, if it is perceived as controlling (Deci et al. 1991). Motivational Interviewing (section 3.2.6) offers guidance in message composition; namely that messages should be unconditionally supporting and non-judgemental.

The Fogg Behaviour Model (section 3.2.7) and Scarcity Theory (section 3.2.8) support the hypothesis that text messages may be an effective medium for delivering feedback aimed at changing behaviour because they have an immediacy that can trigger action and attract the recipient's attention. In terms of message content, the Transtheoretical Model (section 3.2.3) offers guidance on message scripting suggesting that feedback should vary according to stage of change at which participants find themselves on a continuum between having no intention of going to school, through wanting to attend more regularly to having perfect attendance. The Theory of Planned Behaviour suggests that changing individuals' perception of the value of performing a behaviour (such as the importance of attending school regularly) would change that behaviour and so supports the use of messages that not only support self-efficacy but also inform the recipient of the benefits of regular attendance.

4 Changing behaviour through text message interventions

4.1 Introduction

Chapter 2 examined school absenteeism interventions based on performance monitoring, counselling, rewards and praise that reduce absenteeism. While the studies do not explicitly map their effect to theoretical foundations, the theories reviewed in chapter 3 suggest that such interventions would increase self-efficacy and self-esteem through enabling self-monitoring and reflection on performance. This chapter examines how behaviour change interventions have been implemented using mobile phone text messaging as a communication medium. The benefits of text message interventions over face to face interventions are scalability, low cost, and the predictability and fidelity of implementation.

Messages that have been individually tailored to the recipient's circumstances have been found to be more effective than generic, broadcast messages in a large meta-analysis study (Noar et al. 2007). Kreuter et al (1999) define tailoring as "any combination of strategies and information *intended to reach a specific person,* based on characteristics that are unique to that person, related to the outcome of interest and *derived from an individual assessment*" (their emphasis). They suggest that people are more likely to process information that they perceive to be personally relevant and classify levels of tailoring in terms of the level of assessment and the level of individualisation of message content as illustrated in Figure 3. This chapter will describe some of the tailored SMS interventions that have been evaluated and the mixed results that have been found.

While high levels of tailoring are very expensive when feedback is delivered in person or in print media, when feedback is delivered through a computer application or a digital message, tailoring becomes very inexpensive in comparison. Indeed, while software development costs may be high, the marginal cost of tailoring each message is close to zero and this can be seen in the case of text message-based interventions discussed below.

Figure 3: Classification of tailoring from Kreuter et al (1999)

4.2 Landscape of text message behaviour change interventions

Historically, prompts to change behaviour were generally broadcast, for example by announcements in the workplace or in media like television, radio, film, books. With the advent of the Internet, websites, CD-ROM, videoconferencing, phone and email, digital channels for behaviour change intervention opened. In a comparison of interventions incorporating messages delivered by SMS, telephone, email, CD ROM and videoconferencing, those that included support by text messaging were found to be most effective (Webb et al. 2010). Research by Chilukuri et al (2015) found that among low income and racially diverse women, use of mobile internet and SMS was widespread and similar among

non-English speakers but the use of email and installed apps was much lower among non-English speakers. Leite et al (2014) found that while text messaging was used by 74.2% of the foreign born Latino patients surveyed, only 42.8% used email.

There have recently been a substantial number of systematic reviews examining mobile phone apps and text messaging intervention in the health behaviour field. Focuses of reviews included habit disruption (Hermsen et al. 2016), sexual health (Burns et al. 2016), adherence to positive and healthy behaviour among adolescents (Badawy and Kuhns 2017, Loescher et al. 2016, Militello et al. 2012), smoking cessation (Scott-Sheldon et al. 2016), mental health (Rathbone and Prescott 2017, Berrouiguet et al. 2016) and general healthy behaviour change (Armanasco et al. 2017, Buhi et al. 2013, Free et al. 2013, Orr and King 2015, Park, Linda G et al. 2014).

This review focusses on randomised controlled trials of computer generated SMS interventions but also includes some pseudo experimental and qualitative studies where they add to understanding of text message based behaviour change interventions. In order to fully scope the review a keyword search was made of the Academic Search Complete, ERIC, SCOPUS, Medline, Proquest and PsychInfo databases using the following search term “(SMS OR "Text messag*") AND (behavior* OR behaviour*) AND (random*)”. Additional searches were undertaken on Google Scholar and further sources were found through the references in publications reviewed. Appointment reminder interventions were excluded because they treat only a single instance of behaviour. Also, interventions where SMS was used to enable one-to-one communication with a human operator were excluded. The review also excludes interventions where messaging is not isolated from supplementary interventions which introduce confounding effects such as those of printed information, consultations with counsellors, peer support, websites, self-monitoring tools like pedometers and nicotine replacement therapy. These were not only found to be common, 25 out of 35 interventions reviewed by Armanasco et al (2017), but were found to be a statistically significant moderator of effect in that review. Studies with supplementary materials had

an average effect size of 0.23 (CI 0.15- 0.36) while those without only 0.12 (-0.02 - 0.26) Q_B=4.05, p<.05. The goal of this research is to identify the important components of SMS intervention design and to isolate the effect of the messages themselves and therefore such multi-modal interventions were not reviewed.

Overall, systematic reviews have found that SMS interventions show promise, with more published studies showing positive effects than not but note that more quality research was needed (Hermsen et al. 2016, Burns et al. 2016, Badawy and Kuhns 2017, Loescher et al. 2016, Militello et al. 2012). The review by Armanasco et al (2017) examined 35 preventative health behaviour change interventions delivered by SMS, compared effect sizes and undertook a moderator analysis of characteristics such as whether or not they were theory based, the frequency that messages were sent, the length of the study, whether messages were interactive and accepted responses and the whether or not they were tailored. They found that interventions that were **not** based on theory had a significantly larger effect size, as did interventions of long (6-12 month) duration.

There are contrary findings as to whether a theoretical foundation predicts effectiveness. Webb et al (2010) found that theory based SMS interventions had larger effect sizes than those that were not theory based. Armanasco et al (2017) found the opposite. This may mean that current theories of behaviour change do not apply when delivering interventions with the high level of immediacy and tailoring that is possible with SMS as compared with historic delivery methods (Armanasco et al. 2017). Alternatively, it may be a function of the higher number of published studies that do not base their interventions on theory. For example only eight out of thirty eight interventions reviewed by Orr and King (2015) were based on theory. Similarly five out of twenty nine of those reviewed by Park et al (2014), one out of sixteen by Hall et al (2015), and nine out of seventy five reviewed by Free et al (2013) were theory based.

4.2 - Changing behaviour through text message interventions: Landscape of text message behaviour change interventions

In the field of smoking cessation where text messaging interventions have been found to be generally effective (Scott-Sheldon et al. 2016), the majority (19 out of 22) of those reviewed were based on theory. Furthermore, using theory as a basis for design is helpful because it allows findings to be generalized and to inform intervention design in other contexts (Michie et al. 2008). As a result, this research does not abandon theory as a foundation for interventions but instead aims to contribute to the number of studies with theoretical underpinnings.

Few other generalities can be drawn from the reviews. Park et al (2014) found that studies with positive effects usually incorporated a variety of education and motivational messages (which echoes the information and perceived behavioural control aspects of Theory of Planned Behaviour) while message that were not effective were more often more basic and repetitious. All of the interventions reviewed by Park et al (2014) sending tailored or personalized messages had a positive effect. This corresponds with previous observations that repetitive messages result in recipients tuning them out (Franklin et al. 2006, Horner et al. 2017, Boker et al. 2012).

The development of the Behaviour Change Taxonomy (Michie et al. 2013) aims to address the difficulties inherent in comparing behaviour change interventions and allows for more systematic evaluation of intervention components. The Behaviour Change Taxonomy was developed to enable clear classification of behaviour interventions for comparison, replication and generalisation. The taxonomy consists of 93 techniques clustered into 16 categories such as “Schedule consequences”, “Reward and threat”, “Feedback and monitoring”. Categorisation was undertaken by an international group of behavioural change experts through a multi stage process of consensus building (Michie et al. 2013). Each of the SMS interventions discussed below has been classified according to the taxonomy and are summarised at the start of each section together with a classification of whether they were ‘effective’ or not. This is a high-level categorization based on whether there were statistically significant differences

between groups in terms of primary effects of the intervention rather than a comparison of effect sizes and should only be viewed as in indicator.

In this review, messaging interventions are classified according to the level of variability of the messages. First, "Reminder" type interventions are reviewed. These are simple, repetitive messages delivered daily or weekly prompting recipients to perform a task. Next, messaging interventions with more variety are reviewed are typically a pre-determined "Series" of messages. Finally, interventions based on giving "Feedback" on participant behaviour are reviewed. Within each of these groups, interventions are classified by the degree of tailoring in a manner inspired by the classification of tailoring by Kreuter et al (1999) shown in Figure 3 above. Most examples reviewed fit either into the "generic communication" or "tailored communication" and in this review the latter are divided into those that are "tailored with a baseline measurement" and those that are tailored with continuous measurement which are described as "adaptive". See Figure 4.

4.2.1 Reminder messages

Reminder messages have been used in many contexts including prompts to use sunscreen (Armstrong et al. 2009), to take contraceptives (Hou et al. 2010), asthma medication (Strandbygaard et al. 2010, Britto et al. 2017), use acne medication (Boker et al. 2012), anti-retroviral drugs (Pop-Eleches et al. 2011), to aid in antipsychotic therapy and drug adherence (Montes et al. 2012), lupus medication adherence (Ting et al. 2012) and loan repayments (Karlan et al. 2012).

This section of the review will examine the use of simple reminder messages and describe example that are simple reminders, tailored reminders, reminders that require confirmation of receipt and one-off reminders for appointments.

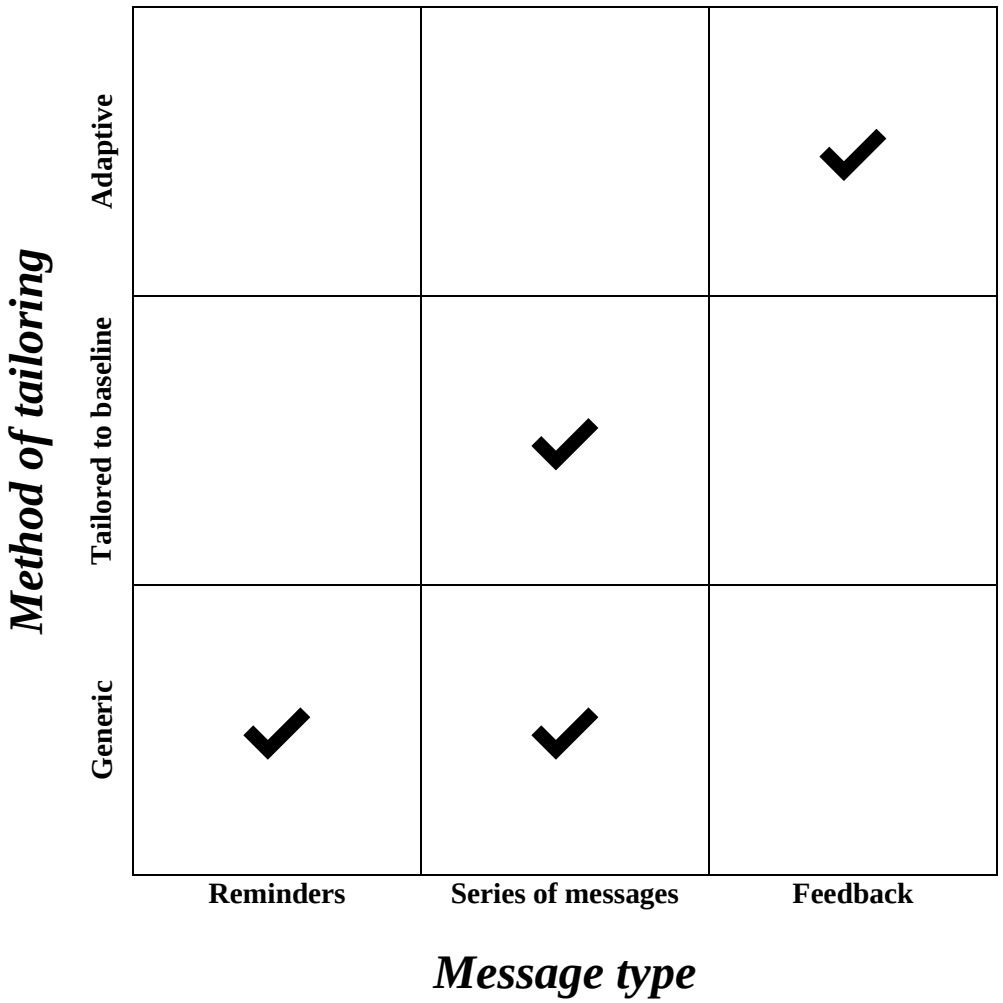

Figure 4: Classification of SMS interventions reviewed

4.2.1.1 Simple reminders

The simplest form of reminder message intervention is to send the same message to each participant each day. Hou et al (2010) sent a daily message "Please remember to take your birth control pill" every day at the same time for 3 months in an RCT of 82 women, measuring adherence with data logging medicine bottles (BCT 4.1 Instruction on how to perform behaviour, BCT 7.1 Prompts and cues; BCT 2.3 Self-monitoring of behaviour). There was no significant difference when compared to the control group. Interestingly, in post intervention interviews the researchers found that 60% of the control group had set an alarm on their mobile phone as their own form of reminder to take the pills, possibly as a

result of counselling given to all participants at the start of the intervention. The idea of simple reminders having similar effects to alarm clock reminders was also noted in an asthma medication reminder intervention (Strandbygaard et al. 2010) which sent the message “remember to take your asthma medication morning and evening. From the Respiratory Unit" (BCT 7.1 Prompts and cues) in which participants reported that they had stopped reading the message and treated it as an alarm because it came at the same time every day. Nevertheless, in the 12 week RCT (N=26), patients receiving the reminders demonstrated 17.8% higher dose adherence than the control as measured by examining the number of doses used between doctor appointments.

Simple reminders like this have also been found effective in reminding participants to brush and floss their teeth (BCT 7.1 Prompts/cues; BCT 6.1 Demonstration of the behaviour; BCT 4.1 Instruction on how to perform the behaviour) (Bowen et al. 2015) as assessed by physiological measurement of plaque levels and in schizophrenia self-reported medication adherence (BCT 7.1 Prompts/cues) (Montes et al. 2012). The poor reliability of self-reporting is highlighted in an acne medication trial by Boker et al (2012) in which participants confirmed adherence by replying to messages but their actual medication use was logged by sensors on the medicine tube (BCT 7.1 Prompts/cues; BCT 4.1 Instruction on how to perform a behaviour). While those receiving messages reported an adherence rate of nearly 75%, the adherence rates of both the control group and message recipients was actually near 35% with no significant differences between groups.

Ting et al (2012) tailored sent adolescent and young adult patients daily reminders to take their medication for lupus erythematosus in an RCT (N=70) (BCT 7.1 Prompts/cues). Messages were the same each day but tailored to individuals’ prescriptions and adherence was measured with a combination of self-reporting, blood tests and examination of pharmacy refill orders. There was no significant difference in adherence.

4.2 - Changing behaviour through text message interventions: Landscape of text message behaviour change interventions

Karlan et al (2012) worked with two banks in the Philippines to encourage on-time loan payments by sending reminders and testing both timing and content of the messages in an RCT (N=943). They tested phrasing messages in terms of loss, in terms of gain and by including the name of the loan officer. They also tested sending the messages one or two days before the due date or on the due date (BCT 7.1 Prompts/cues). There was no overall significant effect of the messages when compared to the control group. However, tailoring the message to include the name of the loan officer was found to significantly reduce late payments when compared to messages without the loan officers name.

Study	Experimental group	Intervention effect
Hou et al (2010)	4.1 Instruction on how to perform behaviour 7.1 Prompts and cues 2.3 Self-monitoring of behaviour	N
Strandbygaard et al (2010)	7.1 Prompts and cues	Y
Bowen et al (2015)	4.1 Instruction on how to perform behaviour 6.1 Demonstration of behaviour 7.1 Prompts and cues	Y
Montes et al (2012)	7.1 Prompts and cues	Y
Boker et al (2012)	4.1 Instruction on how to perform behaviour 7.1 Prompts and cues	Y
Ting et al (2012)	7.1 Prompts and cues	N
Karlan et al (2012)	7.1 Prompts and cues	N
Pop Eleches et al (2011)	7.1 Prompts and cues	Y

Table 1: Behaviour Change Techniques in Simple Reminders

The effect of the message content and frequency was examined in an anti-retroviral drug adherence RCT (N=431) in Sub-Saharan Africa (Pop-Eleches et al. 2011) in which reminders to take medication were sent daily or weekly with either the simple "This is your reminder" text or "This is your reminder. Be strong and courageous, we care about you" (BCT 7.1 Prompts/cues). No significant difference was found between the simple messages and the longer version and weekly messages were found to be more effective than those sent daily, improving adherence (as measured with electronic logging medicine vials).

4.2.1.2 Summary of reminder messages

Overall, the Behaviour Change Taxonomy (see Table 1) offers little guidance as to what contributes to the effectiveness of simple reminder interventions. Providing instruction at the start of the intervention on how to complete the behaviour led to effective interventions in both cases (brushing teeth and treating acne) but may not have been needed in other cases where no instruction was provided and were not effective (taking medication and making loan payments) or in the case of Hou et al (2010) where it is suspected to have confounded the results. As noted in the review by Park et al (2014), the risk of recipients ignoring messages that are repetitive and have little personal relevance is highlighted in some examples of simple reminder interventions.

4.2.2 Messages series

In this class of message, rather than sending repeated reminders, messages are varied and aim to engage the recipient with interesting and educational content that will either increase their knowledge, change their behaviour or prompt them to take action. They can be broadly divided into two types – those that tailor the messages to a baseline measurement of participant characteristics so that messages are focused on individuals' needs or those that send the messages on a prescribed schedule.

4.2.2.1 Prescribed schedule messages

Looking first at messages which deliver the same prescribed list of messages to all recipients without tailoring, successful interventions include increasing adherence to contraceptive pills (Castaño et al. 2012), healthy eating (O'Brien and Palfai 2016), physical activity (Müller et al. 2016) and pain management (Guillory et al. 2015). Unsuccessful interventions include adherence to gluten free diet (Haas et al. 2017), insulin adherence (Louch et al. 2013) and diabetes beliefs (Gatwood et al. 2016).

Castaño et al (2012) created a list of 47 messages to educate young women in New York about taking the contraceptive pill to increase adherence rate over a six month trial. The messages were repeated four times over the six month period and focused on risks, benefits, side effects, use, effectiveness, and mechanisms of action (BCT 5.1 Information about health consequences). Example messages include "The pill improves anaemia" and "Women who use the pill have a slightly greater risk of developing blood clots in their legs." 12 interactive messages were also sent asking recipients to confirm that they were still receiving the messages. In an RCT (N=962), self-reported adherence improved by 10% (54% vs 64%, p=.005).

In an intervention to promote physical activity among older adults Müller et al (2016) sent daily text messages to participants in the RCT (N=43) for twelve weeks to remind participants to do the exercises that they had been shown in a home visit and that were described in a booklet and to give non-contingent praise for doing the exercises (BCT 4.1 Instruction on how to perform the behaviour; BCT 6.1 Demonstration of behaviour; BCT 7.1 Prompts/cues). The messages were all different and based on other physical activity interventions. The participants receiving the messages were found to exercise an average of 3.74 days per week compared with 2.52 days per week in the group that only received the introductory home visit and leaflet (p=.03). Qualitative analysis of semi structured interviews found that 50% of the text message recipients experienced personal barriers to exercise (lack of motivation, laziness) and the

messages “cheering”, ”hopeful” and “inspiring”. The remaining participants experienced few barriers and thought the messages had limited impact.

Study	Experimental group	Intervention effect
Castaño et al (2012)	5.1 Information about health consequences 7.1 Prompts and cues	Y
Müller et al (2016)	4.1 Instruction on how to perform behaviour 7.1 Prompts and cues	Y
O’Brien and Palfai (2016)	1.4 Action planning 2.3 Self-monitoring of behaviour 5.1 Information about health consequences 6.1 Social comparison 7.1 Prompts and cues 9.1 Credible source 9.3 Comparative imagining of future outcomes	Y
Haas et al (2017)	4.1 Instruction on how to perform behaviour 7.1 Prompts/cues	N
Louch et al (2013)	6.3 Information about others’ approval 7.1 Prompts/cues	N
Gatwood et al (2016)	4.1 Instruction on how to perform behaviour 5.1 Information about health consequences 6.3 Information about others’ approval 7.1 Prompts/cues 12.1 Restructuring the physical environment	N
Guillory et al (2015)	2.3 Self-monitoring of behaviour 3.2 Social support (practical) 3.3 Social support (emotional) 7.1 Prompts/cues 11.2 Reduce negative emotions	Y

Table 2: Behaviour Change Techniques in Prescribed Schedule Messages

O'Brien and Palfai (2016) also evaluated text messages as a follow-up to an initial lesson. In an RCT (N=154) of a healthy eating intervention among university students, they gave all students a one time, online test with open response questions, a writing task and personalized feedback. The control group received only the online lesson while the treatment group was sent messages daily at 4:30pm for 30 days. Messages were based on frameworks of goal systems theory (Karoly 1999, Gollwitzer 1999) and focused on implementation planning for goals (BCT 1.4 Action planning; BCT 2.3 Self-monitoring of behaviour; BCT 5.1 Information about health consequences; BCT 6.1 Social comparison; BCT 7.1 Prompts/cues; BCT 9.1 Credible source; BCT 9.3 Comparative imagining of future outcomes) Comparing self-reported fruit and vegetable consumption in both groups showed that the group receiving messages reported eating more vegetables after the intervention (odds ratio 2.93, 95% confidence interval 1.03-8.12, p=.04. There was no significant difference in either group with respect to fruit consumption.

Haas et al (2017) also attempted to help participants control their diet, in this case, helping adolescents diagnosed with celiac disease to adhere to a gluten free diet in a randomised controlled trial (N=61). Adherence was measured by survey instrument and by physiological test with secondary measures of patient reported outcomes, quality of life, symptomology and patient activation (the level at which patients took control of managing their disease). Messages were mainly information based (gluten free recipes, links to restaurant search tools and websites) but also included tips for staying gluten free and interactive quizzes (BCT 4.1 Instructions on how to perform behaviour; BCT 7.1 Prompts/cues). 45 messages were sent over 3 months, two to three times a week. No significant difference was found in diet adherence but those receiving the messages displayed significantly higher levels of quality of life and patient activation (the patient's ability to take an active role in their own care).

In a pilot trial, RCT (N=18) of a diabetes insulin adherence intervention, Louch et al (2013) sent daily messages addressing constructs of the Theory of Planned Behaviour: intention, attitudes, perceived behavioural control and subjective norms of behaviour (BCT 6.3 Information about others' approval;

BCT 7.1 Prompts/cues). While no significant effect was seen in the primary measure of insulin adherence, a weak effect was found for evening injections which was found to be moderated by measures of conscientiousness and consideration of future consequences (CFC) (p=.009) with participants scoring lower on conscientiousness and CFC showing improved adherence rates.

In a pilot study RCT (N=45), Gatwood et al (2016) sent messages to patients with uncontrolled diabetes. The primary measure was percentage of days covered by medication as measured by pharmacy claims and administered measures of Self Determination Theory (SDT) and Health Belief Model (HBM) by survey as secondary measures. The HBM (Rosenstock 1966) is a motivational model that predicts health behavior by examining five determinants: the patient's perceived susceptibility to the condition, how serious they perceive the risks to be, how strong they perceive the benefits of changing their behavior to be, how easy to overcome they perceive the barriers to behavior change to be and what external cues for action they receive. Messages were based on SDT and HBM and focused on education, motivation and reinforcing condition and treatment beliefs and their composition is described in Gatwood et al (2014) (BCT 4.1 Instruction on how to perform behaviour; BCT 5.1 Information about health consequences; BCT 6.3 Information about others' approval; BCT 7.1 Prompts/cues; BCT 12.1 Restructuring the physical environment). There were personalized with subject name, time of delivery (at individual's dosing time), age and medication name. There was no significant difference in adherence or in HBM or SDT constructs between the group receiving messages and the no treatment control group.

Guillory et al (2015) addressed chronic pain in a randomised controlled trial (N=78) over four weeks. The messages were delivered in week two and three with participants in both the treatment and control group recording their perceived pain in a cell phone application over all four weeks. Fourteen messages were written based on a taxonomy of social support (for example, informational support, tangible assistance, network support or emotional support) (Cutrona and Suhr 1992) and delivered two messages per day (BCT 2.3 Self-monitoring of behaviour; BCT 3.2 Social support (practical); BCT 3.3

Social support (emotional); BCT 7.1 Prompts/cues; BCT 11.2 Reduce negative emotions). A comparison of week one and week four measurements of pain showed a significant reduction in perceived pain and pain interference with daily life and an increased positive affect in the group receiving messages when compared with the control group. This effect was not universal but found to only hold for those patients that were married. Like other the interventions reviewed, the strength of intervention appears to be moderated by individual characteristics.

In summary, the effectiveness of prescribed messages is hard to predict based on message characteristics. In terms of the behavior change taxonomy, no clear recommendations can be made. Examination of target behaviours finds that of the ineffective interventions reviewed, two were targeting diabetes and the other, diet (though a second healthy eating intervention was found to increase self-reported vegetable consumption). These may be behaviours that are particularly unsuitable for prescribed messages which, like the simple reminders are less likely to be personally relevant to recipients than the tailored messages discussed below.

4.2.2.2 Tailored to baseline

As described above (section 4.1), tailoring messages to the recipient activates more personal involvement with the with increases the likelihood of behaviour change. This section examines interventions that use a profile of each participant to adjust the messages that they send so that they directly address the recipient as an individual. In this section, the profile is generated before the intervention begins. A later section will review interventions that update the user profile over the course of the intervention for a more closely tailored experience.

Smoking cessation is a field in which SMS intervention has been especially successful, with a review by Scott-Sheldon et al (2016) of 22 interventions applied to 15,593 smokers finding that the odds of smoking abstinence were 1.37 times higher when participants were part of an SMS intervention than in the corresponding control group. A number of smoking cessation interventions fall into the category of a

series of messages tailored to a baseline assessment (Rodgers et al. 2005, Free et al. 2011, Whittaker et al. 2011, Ybarra et al. 2013a, 2013b). The treatments by Rodgers et al (2005), Free et al (2011) and Ybarra et al (2013b) were very similar. All three tailored message content and frequency to a participant selected quit date, chosen within two weeks of randomization with messages tailored to information gathered at baseline like smoking history and perceived barriers to quitting (Rodgers et al. 2005) or concerns about weigh gain (Free et al. 2011). Ybarra et al (2013b) tailored messages closely to the stage of quitting (Transtheoretical Model), with Pre-Quit stage messages focused on clarifying reasons to quit, Early Quit messages on common difficulties and coping strategies, and Late Quit messages about recognizing relapse risks and addressing them. All of the interventions included a social connection (over SMS) to another person attempting to quit, and a Craving support (which sent tips for coping with craving on demand, in response to a text message "crave"). Free et al (2011) and Ybarra et al (2013b) also included a Lapse support (which sent a series of messages aimed at supporting a participant who had yielded to a craving and smoked to restart their quit attempt. Whittaker et al (2011) delivered messages tailored to participants' quit date with SMS and video's of ex-smokers telling their own story and explaining theory. Participants were able to chose videos by people with whom they best connected.

Study	Experimental group	Intervention effect
Rodgers et al (2005)	1.3 Action planning 3.1 Social support (unsupported) 4.2 Information about antecedents 5.1 Information about health consequences 7.1 Prompts/cues 7.3 Reduce prompts/cues 12.3 Avoidance/reducing exposure to cues for the behaviour 12.4 Distraction	Y
Free et al (2011)	1.3 Action planning 3.1 Social support (unsupported)	Y

	4.2 Information about antecedents 5.1 Information about health consequences 7.1 Prompts/cues 12.3 Avoidance/reducing exposure to cues for the behaviour 12.4 Distraction	
Ybarra et al (2013b)	1.3 Action planning 3.1 Social support (unsupported) 4.2 Information about antecedents 5.1 Information about health consequences 7.1 Prompts/cues 7.3 Reduce prompts/cues 12.3 Avoidance/reducing exposure to cues for the behaviour 12.4 Distraction	Y
Whittaker et al	1.3 Action planning 3.1 Social support (unspecified) 5.1 Information about health consequences 7.1 Prompts/cues 12.3 Avoidance/reducing exposure to cues for the behaviour 12.4 Distraction	N
Chow et al (2015)	2.3 Self-monitoring of behaviour 4.1 Instruction on how to perform the behaviour 5.1 Information about health consequences 5.3 Information about social and environmental consequences 7.1 Prompts/cues 9.1 Credible source 10.4 Social reward 12.3 Avoidance/reducing exposure to cues for the behaviour	Y

Table 3: Behaviour Change Techniques in Message Series Tailored to Baseline

Rodgers et al (2005) (N=1705, six months) found that 5.5% of the treatment control compared with 2.4% of the control group (p=.002) had not smoked in the last week after 6 weeks (BCT 1.3 Action planning; 3.1 Social support (unsupported); 4.2 Information about antecedents; BCT 5.1 Information about health consequences; BCT 7.1 Prompts/cues; BCT 7.3 Reduce prompts/cues; BCT 12.3 Avoidance/reducing exposure to cues for the behaviour; BCT 12.4 Distraction). Nonsmoking status was self-reported with positive self-reports asked to confirm their report with a saliva test. The statistic above only counts those self-reported nonsmokers that completed the saliva test (39.8%) and were found to confirm their self-report (18.4%). No physiological tests were done at 12 and 26 weeks and 10.3% were lost to follow-up but assuming that those lost to follow up were smoking again, self-reported quit rates at 12 weeks were 29.0% vs 18.8% (p<.0001). There was no significant difference between groups at 26 weeks.

Free et al (2011) (N=5800, six months) measured self-reported continuous abstinence at six months with physiological confirmation and found that 4.9% vs 1.7% of smokers had quit, relative risk 2.20 (95% confidence interval: 1.80 – 2.68), p<.0001. Treating all those lost to follow-up as smokers: 5.8% vs 4.0% (relative risk 2.14 (95% confidence interval 1.74 – 2.63), p<.0001. The physiological confirmation was found to be important, with 28% of those participants reporting that they had not smoked being found to have recently smoked (BCT 1.3 Action planning; BCT 3.1 Social support (unsupported); BCT 4.2 Information about antecedents; BCT 5.1 Information about health consequences; BCT 7.1 Prompts/cues; BCT 12.3 Avoidance/reducing exposure to cues for the behaviour; BCT 12.4 Distraction).

Ybarra et al (2013b) (N=164, six weeks) relied on self-reporting of smoking status and found that the quit rate in the intervention group was 39% compared with 21% after four weeks (odds ratio 3.33, 95% confidence interval 1.48 – 7.54) and that there was no significant difference after three months (BCT 1.3 Action planning; BCT 4.2 Information about antecedents; BCT 5.1 Information about health

consequences; BCT 7.1 Prompts/cues; BCT 7.3 Reduce prompts/cues; BCT 12.3 Avoidance/reducing exposure to cues for the behaviour; BCT 12.4 Distraction). While the other studies used no treatment controls, Ybarra et al used an attention matched control sending the same number of messages to the control group but focusing them on improving sleep while giving up smoking. A secondary analysis of the data, focusing on the control group by Filion et al (2015) found that the sleep intervention also had significant effect, albeit only on those individuals with poor sleep habits in whom it increased sleep by an average of 82 minutes per night.

Whittaker et al (2011) (N=226, six months) found no significant difference between self-reported quit rate confirmed by saliva test between groups in a smoking abstinence intervention delivering video messages by SMS (BCT 1.3 Action planning; BCT 3.1 Social support (unspecified); BCT 4.2 Information about antecedents; BCT 5.1 Information about health consequences; BCT 7.1 Prompts/cues; BCT 7.3 Reduce prompts/cues; BCT 12.3 Avoidance/reducing exposure to cues for the behaviour; BCT 12.4 Distraction).

Chow et al (2015) tailored messages to individual characteristics in a heart disease prevention intervention randomised controlled trial (N=710) over six months. In a simple, non-interactive program of four messages per week, messages were sent offering advice, motivational reminders and support to change diet and physical activity behaviours. Message composition is described by Redfern et al (2014) (BCT 2.3 Self-monitoring of behaviour; BCT 4.1 Instruction on how to perform the behaviour; BCT 5.1 Information about health consequences; BCT 5.3 Information about social and environmental consequences; BCT 7.1 Prompts/cues; BCT 9.1 Credible source; BCT 10.4 Social reward; BCT 12.3 Avoidance/reducing exposure to cues for the behaviour). Messages were tailored to individual's characteristics, for example no messages about eating meat were sent to vegetarians and only participants that smoked received messages about smoking. Most measures were physiological: primary measure was on fasting lipid levels and secondary measures of blood pressure, heart rate, mass body index, waist

circumference and self-reported fruit and vegetable consumption in prior seven days, medications prescribed and smoking behaviour (confirmed with breath analyser). Compared with the usual care control group, the experimental group showed significantly lower LDL-C, systolic blood pressure, body mass index. The cost of the intervention was approximately $10 for the 96 messages sent over six months. Burn et al (2017) undertook a secondary analysis of the data and with a Markov model, estimated that had the intervention been administered to 50,000 patients, 563 myocardial infarctions and 361 strokes would have been avoided with 1,143 additional quality adjusted life years and savings of $10.56 million.

The findings in this group are particularly strong with three studies being run on large sample groups with physiological measurements to indicate behaviour change finding a significant effect (Rodgers et al. 2005, Free et al. 2011, Chow et al. 2015). The studies were generally effective with strong evidence of behaviour change in groups receiving the interventions. Many of the effective interventions used multiple behaviour change techniques and incorporated two way messaging with on-demand support for cravings. The high level of effectiveness supports the prediction that tailoring messages results in greater likelihood of behaviour change as suggested in section 4.1.

4.2.2.3 Tailored to psychological profile

The following studies investigated this by tailoring intervention messages to the psychological profiles of participants at baseline (Petrie et al. 2012, Kaptein et al. 2012). Both interventions were found to be effective.

Petrie et al (2012) addressed patient beliefs about their asthma and medication tailored to measures from a survey instrument that was used to assess patient beliefs before the intervention began in an RCT (N=216) over 18 weeks. A bank of 166 messages was developed, with 24 messages addressing each of seven target beliefs: short timeline (e.g. “Your asthma symptoms may come and go but your asthma is always there”), low personal control (“You can control your asthma by taking your preventer every day”), low symptoms (“No asthma symptoms doesn’t mean no asthma”), high symptoms (“reduce

your risk of having an asthma attack by taking your preventer every day"), poor understanding ("Asthma is caused by swollen and inflamed airways"), low medication necessity ("Your preventer works best when taken every day"), high medication concerns ("Your preventer medication is not addictive") (BCT 5.1 Information about health consequences; BCT 7.1 Prompts/cues; BCT 15.1 Verbal persuasion about capability). Messages were sent twice per day during week 1-6, once per day in weeks 7-12 and three times per week from weeks 13-18. Participants were sent random messages drawn from the target beliefs in which they scored more than one standard deviation from the mean for that belief. Self-reported adherence among participants receiving messages was significantly higher (57.9% compared with 43.2% among the no treatment control, p=.003) and the intervention group showed significantly higher understanding than the control that asthma was a chronic condition (p=.006), that they had personal control over it (p=.009) and that their medication was necessary (p=.01).

Study	Experimental group	Intervention effect
Petrie et al (2012)	5.1 Information about health consequences 7.1 Prompts/cues 15.1 Verbal persuasion about capability	Y
Kaptein et al (2012)	2.3 Self-monitoring of behaviour 2.4 Self-monitoring of outcomes of behaviours 7.1 Prompts/cues 9.1 Credible source	Y

Table 4: Behaviour Change Techniques in Message Series Tailored to psychological profile

Kaptein et al (2012) tailored messages to measures of individuals' susceptibility to persuasion as described by Cialdini (2001): Reciprocity, Scarcity, Authority, Commitment, Consensus and Liking in an intervention addressing snacking behaviour over two weeks. In a randomised controlled trial that excluding all but those that completed a daily online food journal (N=73 of 162 initial participants) the study compared snacking behaviour between participants receiving messages tailored to their most favoured persuasion technique, messages tailored to their least favoured persuasion technique or randomly selected messages (BCT 2.3 Self-monitoring of behaviour; BCT 2.4 Self-monitoring of

outcomes of behaviours; BCT 7.1 Prompts/cues; BCT 9.1 Credible source). Recipients of both tailored messages and randomly chosen messages reduced snacking behaviour significantly more than those receiving contra tailored messages but the tailored group reduced snacking significantly more than the random message group.

4.2.2.4 Summary of message series

The interventions reviewed in this section ranged from simple series of messages sent to every participant without variation to complex interventions sending individually selected messages to participants based on their individual characteristics, even on their psychographic profiles. Some interventions offered on-demand messages for an even more individualised experience.

As discussed in the introduction (section 4), tailoring of behaviour change messages has long been found to improve intervention effectiveness and this appears to be borne out in the studies reviewed with more individually tailored interventions tending to be more likely to be found effective. Smoking cessation interventions tailored to quit date and personal concerns were found to be effective as were interventions tailored to individual psychological profiles. The next section of this review examines interventions that are tailored still further, giving individualised feedback on recipients' behaviour.

4.2.3 Messages that give feedback

The most technically complex form of message tailoring is to customize each message to respond to the participant's behaviours and to either give feedback to their most recent behaviour or to change the content of the messages to adapt to their recent trend of behaviours.

The following text message interventions respond to participant's behaviour either by asking them to confirm that they have completed a task and return messages tailored accordingly (Darlow and Heckman 2017, Evans and Mays 2016, Cocosila et al. 2009, Hashemian et al. 2015, Suffoletto et al. 2012a), or to keep track of progress toward goals (Bech-Larsen and Grønhøj 2013, 2013, Fassnacht et al. 2015), by using their tracked behaviours to tailor the course of messages to be sent (Adams et al. 2017,

Haug et al. 2009, 2012, 2013), or by using a sensor or data feed to tailor the course of messages without the user needing to record their behaviours (Vervloet et al. 2011, 2012, Agboola et al. 2016, Horner et al. 2017, Gleerup et al. 2010, Pomeranz 2010).

4.2.3.1 Immediate responses to user data logging

The simplest form of feedback to implement is to ask participants whether they have performed a task or not and then to respond to their answer. This is similar to some of the Reminder messages described above which asked participants to confirm that they had completed a task. In these cases however, a response tailored to their answer is sent in reply.

Study	Experimental group	Intervention effect
Hashemian et al (2015)	2.2 Feedback on behaviour 2.3 Self-monitoring of behaviour 10.4 Social reward	Y
Cocosila et al (2009)	2.2 Feedback on behaviour 2.3 Self-monitoring of behaviour 5.1 Information about health consequences 7.1 Prompts/cues 7.3 Reduce prompts/cues 10.4 Social reward	N
Evans and Mays (2016)	2.2 Feedback on behaviour 2.3 Self-monitoring of behaviour 5.1 Information about health consequences	N
Darlow and Heckman (2017)	2.3 Self-monitoring of behaviour 5.1 Information about health consequences	Y
Suffoletto et al (2012a)	2.2 Feedback on behaviour 2.3 Self-monitoring of behaviour 4.1 Instruction on how to perform behaviour 5.1 Information about health consequences	N

Table 5: Behaviour Change Techniques in Message Series that give immediate responses to user data logging

4.2 - Changing behaviour through text message interventions: Landscape of text message behaviour change interventions

Hashemian et al (2015) is an example of an intervention at the nexus of a Reminder with a response and a Feedback message. In an RCT (N=129) evaluating a dental flossing, participants were asked if "Did you floss yesterday?" and sent a response like "Good job! Don't forget to see your dentist twice a year for professional cleaning and oral exams" or "Did you know tooth decay or cavities are common, preventable problems for people of all ages?" (BCT 2.2 Feedback on behaviour; BCT 2.3 Self-monitoring of behaviour; BCT 10.4 Social reward). The trial was only seven days long and found significantly higher rates of flossing in the intervention group ($p=.01$) and higher ($p=.0006$) and more specific knowledge about oral health ($p < .05$). Whether this effect would last over a longer exposure to the intervention is unknown.

In an early and widely cited study of using SMS messages to change health behaviour, Cocosila et al (2009) encouraged participants in the treatment arm of an RCT (N=102) to take vitamin C tablets over the course of a month. Messages were written in a friendly and jokey style from an imaginary friend called Tim. Each day, a message was sent asking if they had taken their tablet for the day. If they confirmed that they had, a reinforcing message including jokes and information and a smiley face was sent. If they had not or did not respond, a more terse reminder of the importance of the healthy behaviour was sent with no joke or smiley. The message frequency faded over the course of the month with reminder messages sent daily for the first two weeks with feedback sent every two days, and in the last two weeks reminders were sent every other day with feedback every three days (BCT 2.2 Feedback on behaviour; BCT 2.3 Self-monitoring of behaviour; BCT 5.1 Information about health consequences; BCT 10.4 Social reward). There was no significant difference in vitamin C adherence between the groups, however a significant correlation was found between engagement (the number of response messages) in the intervention group and the number of pills taken. This echoes observations in the Reminders section, that when participants feel the messages are repetitive and have little personal relevance they ignore them. In this study, some participants may have rejected the importance of vitamin C tablets and not engaged with the intervention while those that did, showed a change in behaviour.

4.2 - Changing behaviour through text message interventions: Landscape of text message behaviour change interventions

Evans and Mays (2016) examined the effect of different styles of feedback in a pilot study focused on reducing indoor tanning behaviour by young women in a short, one week three group randomised trial (N=21). Participants received either loss-framed, gain-framed or balance-framed feedback to a message asking if they had indoor tanned that day. They received two messages in response each day, one with information framed in terms of loss, gain or both and the other encouraging them to continue not tanning or not to tan the following day depending on their answer to the daily enquiry (BCT 2.2 Feedback on behaviour; BCT 2.3 Self-monitoring of behaviour; BCT 5.1 Information about health consequences). While not powered to examine the intervention's effect on behaviour, the study found significantly increase perceived susceptibility to harm as a result of indoor tanning and increase response efficacy beliefs (that participants would be able to stop indoor tanning) after the intervention in all groups.

Darlow and Heckman (2017) addressed sun safety behaviours in an RCT (N=104) that compared a no treatment control with groups that received either a daily message tailored to their beliefs about sun safety ascertained in baseline measures, or a daily behaviour tracking message that asked them if they had tanned that day. Follow-up questions queried why they had tanned, whether they had been indoors or outdoors and what sun protection they used. A fourth group received both tailored messages and behaviour tracking messages (BCT 2.3 Self-monitoring of behaviour; BCT 5.1 Information about health consequences). The primary outcome measures was self-reported sun exposure and protection measures taken (for example, wearing a hat, using sun protection cream, or clothes that cover the skin). Participants receiving tailored messages reported significantly higher sun exposure than those not receiving the tailored messages but also reported significantly higher use of sun protection, suggesting that they had been educated on both the dangers of sun exposure and the measures by which they could mitigate the risk. Participants that tracked their sun exposure reported significantly lower sun exposure than those groups not tracking their behaviours, suggesting that drawing participants' attention to their sun exposure led to them modifying their behaviour.

Suffoletto et al (2012a) evaluated a short term intervention aimed at increasing adherence to antibiotic prescriptions among patients discharged from hospital emergency rooms. Participants in an RCT (N=200) received a message one hour after discharge asking if they had collected their prescription or not. Four follow up messages were sent every six hours until participant responded in the affirmative. Every 24 hours from that time, participants received a message asking how many pills they had taken in the last 24 hours. Upon responding they received either congratulations or a correction together with a reminder to complete the course (BCT 2.2 Feedback on behaviour; BCT 2.3 Self-monitoring of behaviour; BCT 4.1 Instruction on how to perform behaviour; BCT 5.1 Information about health consequences). Participants were interviewed within 24 hours of anticipated completion time of the medication and asked how many pills they had remaining. There was no significant difference in self-reported adherence between the treatment and usual care control group.

These studies, while incorporating interactivity showed very variable effectiveness and suffer from the fact that they are all based on self-reported behaviour measurements. Their intervention design from the point of view of the recipient is little different from simple reminders or message series with no tailoring; the only difference being that they are held accountable by responding whether or not they have completed the behaviour.

4.2.3.2 Feedback on progress towards goals

In addition to giving feedback on individual task performance, when an application is developed to track performance and to chart progress towards goals, a further layer of feedback can be included. Bech-Larsen and Grønhøj (2013) gave a nutrition lesson to all 12 year old participants (N=256) in an RCT and then compared the effect of an SMS based diary on healthy food consumption behaviour. Each day, participants received the message “Reply to this SMS: write how many units (fruits, veggies) you have consumed today. Your SMS must look like this: 2f, 1v”. If they were to respond “2f, 1v” for example, depending on their weekly goal and previous diary entries, they might receive the message

4.2 - Changing behaviour through text message interventions: Landscape of text message behaviour change interventions

"You have now eaten a total of 2 fruit and 4 vegetable units. To reach your goal, you still need to each 17 fruit and 13 vegetable units before next Tuesday." (BCT 1.1 Goal setting (behaviour); BCT 1.5 Review behaviour goals; BCT 2.2 Feedback on behaviour; BCT 2.3 Self-monitoring of behaviour; BCT 4.1 Instruction on how to perform the behaviour; BCT 7.1 Prompts/cues) The intervention was delivered on alternate weeks (weeks 2, 4, 6, and 8) with two lessons for a dietician in weeks 5 and 7 to both groups. A food survey was taken in weeks 1 and 15 and there was no significant difference between classes of students that received the SMS messages and those that did not.

Study	Experimental group	Intervention effect
Bech-Larsen and Grønhøj (2013)	1.1 Goal setting (behaviour) 1.5 Review behaviour goals 1.6 Discrepancy between current behaviour and goal 2.2 Feedback on behaviour 2.3 Self-monitoring of behaviour 4.1 Instruction on how to perform the behaviour 7.1 Prompts/cues	N
Fassnact et al (2015)	1.1 Goal setting (behaviour) 1.6 Discrepancy between current behaviour and goal 2.2 Feedback on behaviour 2.3 Self-monitoring of behaviour 4.1 Instruction on how to perform the behaviour 7.1 Prompts/cues 10.4 Social reward	Y

Table 6: Behaviour Change Techniques that give feedback on progress towards goals

Fassnact et al (2015) also tracked progress towards goals in children's health behaviour in diet and physical activity. All participants (N=49) aged 8-10 received health education lessons and set personal goals but a randomised group also received a pedometer and were asked to send daily text messages logging their daily steps, eating habits and screen time. They received responses like "Great, you met your goal for physical activity and screen time! What happened to fruits and vegetables?" (BCT

1.1 Goal setting (behaviour); BCT 1.6 Discrepancy between current behaviour and goal; BCT 2.2 Feedback on behaviour; BCT 2.3 Self-monitoring of behaviour; BCT 4.1 Instruction on how to perform the behaviour; BCT 10.4 Social reward; BCT 7.1 Prompts/cues) Participants responded with their data on 61% of days and 71.4% of participants reported that they enjoyed sending the messages. There was a significant and positive interaction between fruit and vegetable consumption and time and group when controlling for gender and baseline levels, also for screen time but not for physical activity.

It is interesting to contrast these two studies as they are very similar, the main difference being that Fassnact et al (2015) included a social reward in the form of praise while Bech-Larsen and Grønhøj (2013) did not; the former having a significant effect on behaviour but not the latter. The practice of motivational interviewing stresses non-judgemental help to achieve goals; the social reward given when participants are successful may be important for countering negative feedback associated with failing to meet a goal.

4.2.3.3 Adapting goals and messages based on performance

Data on participants' behaviours can be used to deliver more personalized goal related feedback by dynamically changing goals or the focus of messages to match recent performance.

In a study evaluating smoking cessation intervention among young people, Haug et al (2013) (N=755) examined the effect of tailoring feedback to participants' stage of change (see Transtheoretical Theory, section 3.2.3) as measured each week with an SMS message that asked "Have you recently smoked cigarettes? options (1) "Yes, and I do not intend to quit" (2) "Yes, but I am considering quitting", (3) "Yes, but I seriously intend to quit", or (4) "No, I quit smoking". Participants' current stage of change was controlled by their response: 1 = Precontemplation, 2 = Contemplation, 3 = Preparation, 4 = Action and messages were tailored to their current stage. For example, messages for those in Pre-intentional stage focused on risks and costs of smoking or for those in the Action phase were focused on coping with cravings and making use of social supports (BCT 2.2 Feedback on behaviour; BCT 5.1 Information about

health consequences; BCT 5.3 Information about social and environmental consequences; BCT 10.9 Self -reward; BCT 12.2 Restructure social environment; BCT 12.3 Avoidance/reducing exposure to cues for he behaviour). The primary outcome measure was self-reported seven day smoking abstinence and no significant difference was found between groups but the number of cigarettes smoked per day was reduced significantly more in the treatment group (10.0 per day vs 8.5, p=.002 as intention to treat). Attrition was low (11%) and engagement was high with 91% of responses sent as expected.

Muench et al (2017) compared the effects of messages tailored to baseline characteristics with messages tailored to recent behaviour to give adaptive feedback in an alcohol consumption intervention. They tailored messages to binge drinking and regular drinking habits, solitary and social drinking habits, predicted effort to reduce drinking, acceptance of the need to reduce drinking, self-efficacy, gender, and which days and times participants drink most often (BCT 2.3 Self-monitoring of behaviour; BCT 4.1 Instruction on how to perform the behaviour; BCT 4.2 Information about antecedents; BCT 5.1 Information about health consequences; BCT 5.3 Information about social and environmental consequences; BCT 7.1 Prompts/cues; BCT 9.1 Credible source; BCT 12.3 Avoidance/reducing exposure to cues for the behaviour; BCT 12.4 Distraction). In a randomised controlled trial (N=152) the compared the effectiveness of different styles of messages and tailoring: loss-framed, gain-framed, statically tailored to baseline data and adaptively tailored to whether participants met the previous week's goal, with extra messages sent when they were most likely to drink and an on-demand message service where they could request support with keywords like: "tempt", "drink", "heavy", "win" and "regret". All groups, including a no message group, tracked their messages by sending daily text messages detailing their alcohol consumption. There were no significant differences between groups but the effect sizes of the adaptive feedback group were consistently the highest across measures of drinks per week, number of heavy drinking days and number of days without drinking. The study was not sufficiently powered to measure differences in effect size between groups.

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Study	Experimental group	Intervention effect
Haug et al (2013)	2.2 Feedback on behaviour 5.1 Information about health consequences 5.3 Information about social and environmental consequences 10.9 Self -reward 12.2 Restructure social environment 12.3 Avoidance/reducing exposure to cues for he behaviour	Y
Muench et al (2017)	2.3 Self-monitoring of behaviour 4.1 Instruction on how to perform the behaviour 4.2 Information about antecedents 5.1 Information about health consequences 5.3 Information about social and environmental consequences 7.1 Prompts/cues 9.1 Credible source 12.3 Avoidance/reducing exposure to cues for the behaviour 12.4 Distraction	N
Adams et al (2017)	1.1 Goal setting 1.4 Action planning 1.6 Discrepancy between current behaviour and goal 2.2 Feedback on behaviour 2.3 Self-monitoring of behaviour 3.3 Social support (practical) 7.1 Prompts/cues 10.4 Social rewards 10.8 Incentive outcome	Y

Table 7: Behaviour Change Techniques in feedback interventions that adapt goals and messages based on performance

The effect of adapting goals to recent performance over using static goals was investigated in a physical activity promotion intervention by Adams et al (2017) in a 2x2 factorial randomised controlled trial (N=96) that investigated the differences in effects in adaptive and static goals and delayed vs immediate rewards and feedback (BCT 1.1 Goal setting; BCT 1.4 Action planning; BCT 1.6 Discrepancy between current behaviour and goal; BCT 2.2 Feedback on behaviour; BCT 2.3 Self-monitoring of behaviour; BCT 3.3 Social support (practical) ; BCT 7.1 Prompts/cues; BCT 10.4 Social rewards; BCT 10.8 Incentive outcome). Participants in static goals groups were set a daily step goal of 10,000 steps while those in the adaptive goals group were set a new goal each day calculated as the number of steps ranked at the 60% percentile of their last 9 days logged steps. Participants receiving immediate feedback, motivational sayings and rewards were congratulated and rewarded with points that they could exchange for cash if they had met their goal. Those receiving delayed rewards received neither feedback nor points but had been promised the same level of cash reward as they would have received in the immediate rewards group at the start of study, to be paid at the end of the study.

The results showed a significant interaction between adaptive/static goals x immediate/delayed rewards x phase (baseline/intervention) p=.010 with a greater initial increase in steps in the static goals group whose goal was 10,000 steps per day than the adaptive goal group whose goal was generally less. However, while the increase faded in both groups it faded significantly faster in the static goals group which suggests that the adaptive goals may have been more accessible and less discouraging than the static 10,000 step goal. Comparing immediate rewards with delayed rewards showed that immediate rewards were more effective. Not noted in the research paper, but worthy of consideration is this may have been confounded by the nature of the “reward” which included praise when participants were successful and a non-judgmental reminder of the current goal when they were not.

The greater degree of tailoring afforded though adapting the tone of the intervention to each participants’ performance appears to have been effective though the studies lack the rigor of those

described in section 4.2.2.2. In the case of Haug et al (2013), messages were tailored to Stage of Change and while there was no significant difference between groups in terms of cessation, the intervention groups smoked significantly fewer cigarettes. Muench et al (2017) did not find significant differences between groups (as the study was not powered to do so) but found the strongest effect sizes in the groups receiving messages tailored feedback based on recent performance. Adams et al (2017) found that tailoring goals to recent performance to keep them "within reach" of participants resulted in the interventions being effective over a longer period than having a static goal. Echoing the findings in section 4.2.3.3, those inteventions offering rewards (either social or material) were found to be effective.

4.2.3.4 Sensor and third-party data driven feedback

Feedback may be based on sensor and third-party data rather than on participants actively logging their behaviours (Vervloet et al. 2011, 2012, 2014, Gleerup et al. 2010, Pomeranz 2010, Agboola et al. 2016).

Vervloet et al used electronic medicine bottles in a diabetes medication adherence intervention not only to measure adherence but to feed data into their SMS intervention (Vervloet et al. 2011, 2012, 2014). The intervention was simple, if participants took their medication on time they were not sent a message, if they did not open their medication bottle during their dosing window as set by themselves at the start of the intervention, they received the message "Have you taken your medication yet? Please take your medication as prescribed by your health care provider" (BCT 2.2 Feedback on behaviour; BCT 7.1 Prompts/cues). In a randomised controlled trial (N=104) over six months, significantly more participants receiving the messages took their medication within one hour of the scheduled time (50% vs 39%, p=.065) and most found it a positive experience (Vervloet et al. 2012). In a secondary analysis (Vervloet et al. 2014), the authors describe the same experiment with the same participants plus a further control group that did not receive the electronic medicine vials and measure the long term effect of the intervention by monitoring participants' pharmacy refills. At baseline, refill rates were comparable but

after year one and year two were significantly higher in the group receiving the text messages when compared to either control group (year one: 79.5% vs 54.5% vs 73.1%, p<.001; year two: 80.4% vs 68.4% vs 65.6%, p<.01, in SMS group vs control group vs monitor but no SMS group respectively).

Study	Experimental group	Intervention effect
Vervloet et al (2011, 2012, 2014)	2.2 Feedback on behaviour 7.1 Prompts/cues	Y
Gleerup et al (2010)	2.2 Feedback on behaviour	Y
Pomeranz (2010)	1.3 Goal setting (outcome) 1.6 Discrepancy between current behaviour and goal 6.2 Social comparison	Y
Agboola et al (2016)	1.3 Goal setting (behaviour) 2.2 Feedback on behaviour 7.1 Prompts/cues Others not clear	Y

Table 8: Behaviour Change Techniques in feedback interventions driven by sensor and third-party data

Gleerup et al (2010) used smart electricity meter data to trial a variety of message styles focused on reducing electricity use in homes. In an RCT (N=1452) with three experimental groups and two control groups (in order to test for an experimental effect, one was blind and the other informed that they were taking part in a study testing the effect of feedback). Participants could receive the feedback by email of SMS message and most preferred email and the three experimental groups had differing levels of control over what type of alert they wished to receive (BCT 2.2 Feedback on behaviour). There was a significant reduction in electricity use (3%, $p < .05$) in the group with the most control over message type. The authors included a cost benefit analysis: the intervention cost 6USD (4.4EUR) per family to implement and generalizing the 3% observed would result in 37USD (27EUR) in savings over the same period.

4.2 - Changing behaviour through text message interventions: Landscape of text message behaviour change interventions

In the third essay of their doctoral thesis, Pomeranz (2010) describes a study investigating how text messages tailored using data provided by participants banks could encourage saving among low income entrepreneurs in Chile. In earlier work focusing on a peer-support savings intervention (2nd essay of the same publication) Pomeranz found that participants of a peer-support group, based on weight loss programs, made more deposits to savings accounts than a control group that did not receive any peer support. To follow up, she investigated whether text messages could provide that same support. A sample of 873 participants were assigned to one of three groups: a "Savings Buddy" group, a "Savings Comparison" group or a control group. In an initial interview, participants were asked to set savings goals. Members of the Savings Buddy group were sent a text message each week informing them whether they had met their goal or not. A copy of the message was sent to their savings buddy and they were reminded that their buddy was receiving it. The Savings Comparison group received messages confirming whether or not they had met their savings goal and telling them how well they were doing compared to other participants of similar age (BCT 1.3 Goal setting (outcome); BCT 1.6 Discrepancy between current behaviour and goal; BCT 6.2 Social comparison). The control group received no messages. During the first two months, baseline savings data was recorded but no messages sent. Then, for a period of three months, weekly messages were sent and a two month follow-up period with no message recorded savings behaviour without the reminders.

The study showed that recipients of the messages did make significantly more deposits while text messages were delivered than in the baseline period and savings behaviour declined to baseline levels once the intervention ended. There was no significant difference in the savings behaviour between the Savings Buddy and Savings Comparison groups which suggests that it is not the peer-pressure element of a savings support group that encourages savings but simply some kind of regular accountability and trigger to reflect on making a deposit.

4.2 - Changing behaviour through text message interventions: Landscape of text message behaviour change interventions

In a physical activity promotion intervention for patients with diabetes, Agboola et al (2016) provided participants with a pedometer to measure their daily steps which automatically uploaded their step count to the researchers' server whenever participants were close to their computer. In a six month randomised controlled trial (N=126), all participants used the pedometer and those randomised to the treatment group also received daily text messages. In the morning they received a message based on their previous days step count (or a reminder to allow their pedometer to upload the data) , for example "TTM study: as of 8:27am you were active for 45 minutes yesterday which is 75% of your daily goal". In the afternoon, they received another message that was tailored to their stage of change (see Transtheoretical Model, section 3.2.3), for example, in the Contemplation stage: "TTM Study: Take a minute to consider these questions: 'What are some benefits of becoming more physically active? What are the benefits of staying the same?' or Action phase: "TTM study: How can you add steps to your regular activity? Can you take the stairs instead of an elevator?" Twice a week, on Tuesdays and Thursdays the messages were interactive, for example, "How would you rate your stress level over the last few weeks? 1=no stress 2=some stress 3=3 moderate stress, 4=a lot of stress" with a follow-up tailored to response. e.g. if they answered 3: "Sounds like a lot to handle, how about talking with your doctor about stress management tools?". Participants stage of change was initially assessed at baseline and then updated monthly according to whether or not participants had met their step goals and making use of text message responses. There were no significant differences between groups when examining step counts over the entire six months but the intervention group had significantly higher step counts in months 3 and 4.

A secondary, qualitative analysis was undertaken of the participants' impressions of the interventions (Horner et al. 2017) which found that participants found the messages educational, useful and that they had increased their understanding of diabetes, more than half found the tangible nature of the step count feedback as motivating because it felt like someone was monitoring them, several felt that "someone cared" or referred to the intervention as "my private, personal little cheerleader" though some were frustrated by the repetitiveness of the messages and many started to ignore them "whey they are

repetitive, they were nagging because it's like, 'I already read this, I need something new' … it's kind of sad, but at the end of it, it was like really annoying".

The studies in this section benefit, by their very nature, from avoiding the unreliability of self-reported data (discussed in section 4.2.1.1) which makes their findings particularly compelling. The interventions with the clearest effectiveness were Vervloet et al (2011, 2012, 2014) and Gleerup et al (2010) which were the simplest, simply prompting participants and giving them feedback on their behaviour.

4.3 Summary of findings

The goal of this chapter was to examine examples of interventions delivered by SMS and to identify characteristics that predicted effectiveness. As has been seen, there is a broad range of intervention styles and even the use of the Behaviour Change Taxonomy does not make identifying common components straightforward. However, some pointers are apparent. While simple interventions based on static reminders are effective in some cases, there is a risk that recipients will simply ignore them. As found by Park et al (2014), messages are tailored more closely to participant characteristics and performance, interventions are more often effective. Furthermore, the more robust evaluations using physiological or other objective measures are found to coincide with higher degrees of tailoring.

In this review of text message driven behaviour change interventions, mixed results can be seen for reminder-based interventions and pre-scripted message sequences. Repeating reminders were found to be effective when addressing simple behaviours like taking a pill or brushing one's teeth but not for more substantive behaviours like increasing daily exercise. The pre-scripted educational text message campaigns were most effective when they offered advice and support. For example, when explaining how contraceptive pills affected one's body, how to apply to college or providing motivational support for diet change or pain management.

4.3 - Changing behaviour through text message interventions: Summary of findings

Interventions that focus on the individuality of the recipient were found to be generally effective. A host of smoking cessation interventions tailored to individuals smoking beliefs and stage of change were found to be effective, as were intervention tailored to psychological profiles of participants. It can also be noted that the effectiveness of interventions was found to be moderated by recipient characteristics (Filion et al. 2015, Guillory et al. 2015).

Most of the studies reviewed compared a single intervention with a no treatment control which does little to build an understanding of what components of the intervention are most important. There were some studies that compared framing messages in terms of loss or gain (Evans and Mays 2016, Karlan et al. 2012) but they found no significant differences. Karlan et al (2012) also investigated the effect of including the loan officer's name in messages in a payment support intervneiton and found them to be more effective than messages with no name. Two studies directly compared tailored and non-tailored messages and found that tailored messages were more effective (Darlow and Heckman 2017, Muench et al. 2017). Finally, Pop-Eleches et al (2011) found no difference in effect between long and short messages but did find that weekly messages were more effective than daily messages (it should be noted that the messages were identical each day/week) which echoes the findings in section 0 that repeating messages can become annoying.

Finally, interventions that invisibly provided feedback to participants by tracking their behaviour through some type of sensor were effective at reminding participants to take pills, to use less electricity, or to save more money. These also avoid the inaccuracies of self-reported outcome data that was so dramatically illustrated by Boker et al (2012) in which the self-reported adherence rate was close to 75% but the actual adherence rate was 35% (section 4.2.1.1).

This review suggests that tailoring messages to individual recipients' circumstances is important, both in terms of making the messages less repetitive and annoying and in order for them to be more personally relevant and therefore more likely to effect behaviour change. Furthermore, when interventions tracked and commented on progress towards goals they were more effective when they offered praise and

encouragement or modified goals accordingly. There is little study of the components of feedback, no reports of comparisons of feedback timing were found and, apart from one study that used video messaging, only text-based interventions were found to have been evaluated.

5 Study Protocol

5.1 Introduction

This chapter describes the process of designing the experimental protocol for the pilot study described in chapter 6 below based on the theory and previous practice discussed in the literature review. First, the development of a logic model is described. This model formed the framework for the experimental methodology, intervention design and technical implementations that follow (see Figure 5).

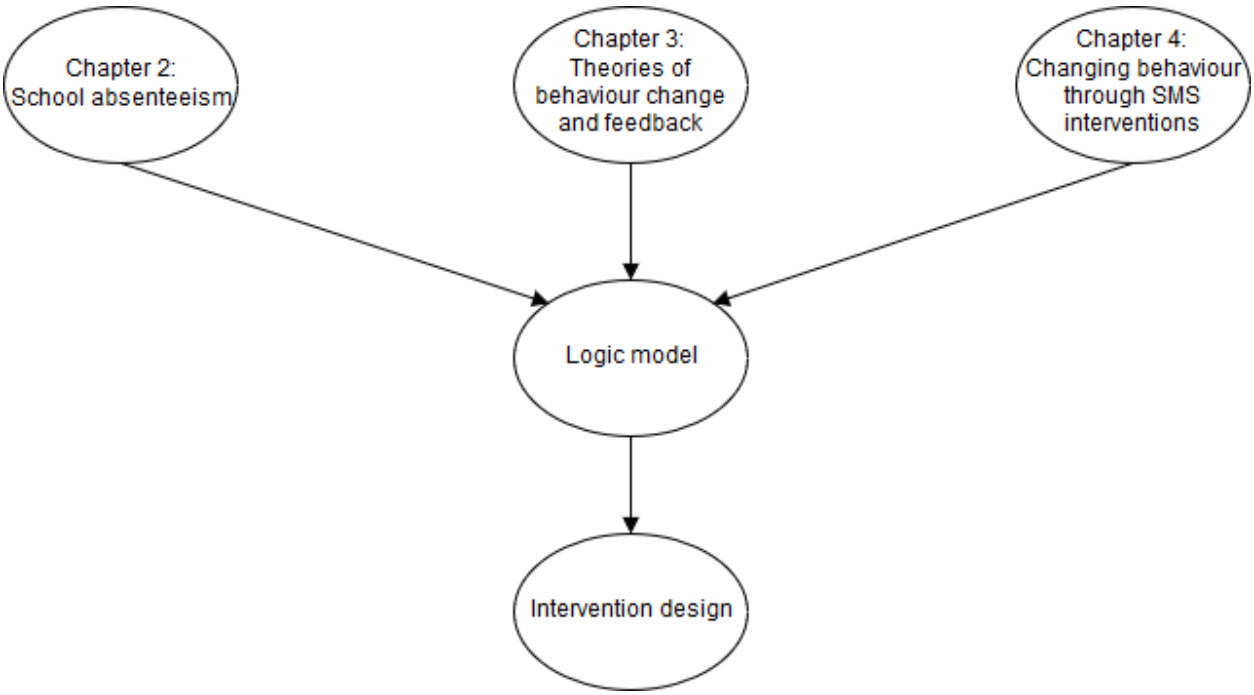


Figure 5: Development of the research protocol

5.2 Logic model

A logic model describes the connections between behavioural determinants, intervention activities that address those behaviours and short and long term outcomes (Kirby 2004). Its inclusion in this thesis addresses the lack of clear reporting on intervention mechanics and theoretical foundations that has been reported in both the attendance intervention literature (Maynard et al. 2013) and SMS intervention literature (Fjeldsoe et al. 2009).

5.2 - Study Protocol: Logic model

The review of absenteeism interventions (see section 2.6) showed that many of the interventions focussed on helping students to track and reflect on recent attendance and making them accountable to counsellors, courts and teachers for their absences. Many of the interventions also rewarded or in some way celebrated student success. While little explicit mapping of intervention characteristics to theory was found, the examination of common theories of behavioural change in chapter 3 suggests that many of these interventions are applying components of Social Cognitive Theory in terms of helping to increase students' self-efficacy in regard to their attendance through "self-monitoring, self-judgment and self-reaction" (Bandura 1991). Connections were also reported between absenteeism and both low self-esteem and a low perceived autonomy at school.

SMS was chosen as the medium for electronic message communication (which can be tailored at low cost) in this research for the following reasons. First, it would not require participants to install any software on their phone, as would be required with custom apps. Secondly, it was chosen over email to avoid the circumstance where participants did not routinely use email and would not see the messages as described in section 4.2.

In the literature surrounding SMS interventions, designs based on theoretical foundations are not correlated with intervention effectiveness. This may be because the immediacy of feedback possible with SMS changes the assumptions under which traditional behaviour change theories which were developed (Armanasco et al. 2017). Or it may be due to the youth of the field of study and under-representation of theory based interventions. However, behaviour change interventions are generally found to be more effective and more easily generalised to other domains when based on theory (Michie et al. 2008, Webb et al. 2010, Scott-Sheldon et al. 2016). The participants in the studies described in this thesis were drawn from a population of students enrolled in an alternative high school that served students who were either deemed to be at high risk of dropping out or who had previously dropped out of school. Because it was anticipated that they were unlikely to engage in an elaborate design process, the intervention design was

grounded in theory and evidence from prior experimentation rather than the qualitative analysis of interviews with participants described in the person-centred design process (Yardley et al. 2015).

Setting goal and tracking and rewarding performance has been previously studied in the context of school attendance (Hess et al. 1990, Hess 1990, Herrick 1992, Tichenor 1991) but with few conclusive results (see section 2.6.3) and in SMS interventions (Bech-Larsen and Grønhøj 2013, Fassnacht et al. 2015, Adams et al. 2017, Pomeranz 2010, Agboola et al. 2016) with mixed results (see section 4.2.3). The Behaviour Change Taxonomy classifies these interventions as BCT 1.1 Goal Setting and BCT 1.6 Discrepancy between Current Behaviour and Goals (Michie et al. 2013). This model was rejected because Self Determination Theory and student autonomy have been highlighted in the review of student absenteeism (see sections 3.2.5 and 3.2.9) and there was a risk that requiring participants to set explicit goals would be perceived as being too "controlling" which may reduce participant autonomy and therefore be counter-productive. Instead feedback was provided on recent attendance in similar ways as in interventions described in section 2.6 to enable participants to reflect on their performance and develop their perceived self-efficacy. Participants were then free to set whatever personal goals they wished, without having goal setting imposed upon them and so avoiding the reduction of participants' perceived autonomy.

A decision to deliver the support by SMS messages directly to participant cell phones was made because cell phone ownership is almost ubiquitous among high school students in the US and text messaging is a well understood medium through which highly personalized messages may be delivered directly to a very large number of students at very low cost. Multi-media messaging (MMS) operates in most cell phones in the same way as text messaging but can combine text messages with pictures and video. Both SMS and MMS are referred to as SMS in the remainder of this thesis. We chose to use SMS as the medium over the use of a custom built cell phone app because, while the app would allow a richer and more interactive style of delivery, there is a risk of students not using the app (Chilukuri et al. 2015, Leite et al. 2014). With SMS, the messages would always receive some level of attention as they are

delivered to the inbox used by the recipient throughout the day. Furthermore, by using a server-based technology the risk of technical problems on the participants' diverse devices was reduced.

Because the intention was to support students individually, intervention design was inspired by attendance literature surrounding group counselling and mentoring (Cabus and De Witte 2015, DeSocio et al. 2007, Newsome 2004) (section 2.6.2) and contingency contracting and rewards in which goals were set and progress tracked (Hess et al. 1990, Hess 1990, Herrick 1992, Tichenor 1991) and in which no goals were set but students were rewarded according to their attendance rates (Brooks 1975, Cole 2011, Ford, J. and Sutphen 1996, Licht et al. 1991, Zweig et al. 1979, Flanagan 2006) (section 2.6.3). As noted earlier, explicit goal setting and tracking were rejected as being too controlling, however the literature review showed that behaviour tracking and reflection without explicit goals or targets were common features of interventions through sticker charts or punch cards (Cole 2009, Ford, J. and Sutphen 1996, Zweig et al. 1979) or teacher signatures (Brooks 1975, Flanagan 2006) that were often effective at reducing absences.

While these performance tracking interventions generally rewarded students with tangible rewards, the act of monitoring their own attendance and reflecting upon it may itself increase their perceived self-efficacy in attending school. Tangible rewards were rejected as being both a risk of reducing intrinsic motivation (Deci et al. 1991) and as reducing the scalability and increasing the cost of the intervention but incorporated the features of tracking attendance and creating opportunities for reflection on performance.

The Transtheoretical Model suggests that people have different support needs at different stages of the behaviour change cycle. For example, before they have chosen to stop smoking they need very different supports than once they have been non-smokers for several weeks (Reback et al. 2015, Haug et al. 2009). In the same way, feedback was tailored to participants' recent average attendance level with different messages being sent to students who usually had good attendance than those who were often absent.

Because attendance is logged by teachers for each class period on a central database system, there was no need to ask students to log their own attendance. While doing so may have created additional opportunities for reflection, it would also introduce inaccuracies through over or under-reporting, missed data and simple error.

In designing the pilot study, the intervention design (described below) was focussed on developing self-efficacy through messages that offered praise when students were performing well with encouragement to do better where appropriate. All messages were composed according to the practice of motivational interviewing to be supportive and non-judgemental.

Problem statement: Missing school is a widespread behaviour that has negative impacts of students' lives both during school years and in later life. While some factors contributing students' absenteeism are beyond the scope of an SMS behaviour support program, support can be given to factors such as low self-efficacy, feelings of autonomy in school, self-esteem and motivation to graduate. The major risk factors addressed by the intervention were low self-efficacy, low self-esteem and perceived autonomy.

Behavioural Determinants	Activities to address determinants	Intermediate effects	Outcomes
• Low self-efficacy • Low self-esteem • Lack of perceived autonomy in school • Lack of motivation to attend school every day	• Praise when attending regularly (SCT, SDT, TPB, TTM) • Drawing attention to good attendance (SCT, SDT, TPB) • Information about the importance of regular attendance (TPB) • Information about opportunities after graduation (TPB) • Enable self-monitoring and reflection (SCT, SDT) SCT: Social Cognitive Theory SDT: Self Determination Theory TPB: Theory of Planned Behaviour TTM: Transtheoretical Model	• Increased self-esteem • Higher perceived autonomy in school • Increased self-efficacy regarding ability to attend school regularly • Increased motivation to attend school every day • Increased motivation to graduate	• Increased rates of attendance

Figure 6: Intervention logic model

5.3 Research Questions

The research questions behind this work were whether an intervention delivered by SMS can improve school attendance behaviours among at-risk youth and to identify theory-based components of the intervention to inform intervention designers that follow. The goal of the pilot study was to test the experimental design and technical feasibility of the proposed intervention.

The literature review shows that SMS interventions are more often than not, effective in changing behaviours ranging from improving medication adherence to stopping smoking and may be an effective method of delivering an intervention to improve school attendance. The literature surrounding school attendance interventions suggests that factors affecting school attendance that can be addressed at an individual level are self-efficacy, self-esteem and perceptions of autonomy at school.

The following describes the application of the logic model to design and evaluate the components of an intervention aimed at increasing school attendance through supporting participants' self-esteem, self-efficacy and autonomy.

5.4 Experimental design

Using SMS to encourage behaviour change has been a growing field of research, especially in health focused interventions; however while results tend to be positive, systematic reviews find few common predictors of effectiveness (Armanasco et al. 2017, Badawy and Kuhns 2017, Burns et al. 2016, Hermsen et al. 2016, Klimis et al. 2017, Loescher et al. 2016). The research aimed to not only evaluate an SMS intervention but also to examine its theoretically derived components and their association with effectiveness to help inform future research in designing new interventions. To this end, all studies made comparisons between three groups: one being a no treatment control group and the other groups comparing the effect of different types of intervention messages.

In the Pilot Study (chapter 6), two experimental groups were compared with a control group. The first experimental group was sent messages of the type "Message Series" (see section 4.2.2) that were not

tailored in any way but were selected at random from a database of 35 messages to avoid repetition (message texts that had already been sent were excluded from the random selection process) (SERIES) . Students in the second group were sent messages of type "Feedback" consisting of praise and corrective feedback on occasions of particular attendance behaviour that were adapted to the recipient's recent attendance behaviour (ADAPT).

Messages were sent on a variable schedule, only when student attendance matched particular criteria, to mimic natural interactions with teachers and staff. So that participants in the standard message group were only sent messages when adaptive feedback group were sent messages, participants from the two groups were "yoked" together in order to control for the frequency of messages (Davis and Bitterman 1971, Hoover and Deitchman 1972) (see section 6.2.1).

A Weekly Poll of students' intention to attend was also made by SMS. The weekly poll described above, was sent to all students in the experimental groups on Tuesday evenings to assess students' motivation to attend. The poll was not sent to students in the control group because the control group was to receive no messages. The students were sent a message that read: *"Hello - how much do you want to go to school this week? Answer with score of 1-10. [1 means not at all, 10 means very much]. Just reply with your answer."*

Short and informal interviews were conducted with participants at the end of the study to elicit their impressions of the intervention.

5.5 Intervention groups

5.5.1 Adaptive messages (ADAPT)

The text messages focussed on delivering praise so as to support participants' self-efficacy when they were attending successfully. So that messages did not annoy participants who came to school regularly, wordings were adjusted according to how often then had been attending recently (their stage of change). See Table 41 in Appendix 11.3 for a list of messages and conditions for their sending. Messages

were only sent when student attendance met one of the conditions and so were delivered on a variable schedule rather than every day. A second set of messages and conditions was scripted for the family members that participants nominated when they agreed to participate in the study (see Table 42).

Multiple versions of every message template were saved in the data table in different languages as specified by the Language column. Participants chose their preferred language when they agreed to participate in the study. In this study, messages were saved in just two languages (English and Spanish) but any number of languages would be possible.

The Behaviour Change Taxonomy (Michie et al. 2013) classifies the techniques used in the interventions as including: 2.2 Feedback on Behaviour; BCT 2.7 Feedback on outcomes of behaviour; BCT 7.1 Prompts/cues; BCT 9.1 Credible Source; and BCT 10.4 Social Reward.

5.5.2 Series messages (SERIES)

A series of messages was scripted (see Table 43) containing information about college and careers and motivational quotations about persistence. Their inclusion was based on the importance of information in behaviour change as a means to changing perceptions of social norms and therefore changing a recipient's intention (see Theory of Planned Behaviour, section 3.2.4). These were saved in both English and Spanish.

Participants assigned to the SERIES group were "yoked" to a participant in the ADAPT group (see section 5.4) and whenever their associated participant in ADAPT met a message criteria and was sent a message, their associated participant in SERIES was sent a randomly selected message from the series. In order to avoid repetition, once a message had been sent to a participant it was available for sending to that participant again until all messages in the database had been sent when the random selection began again.

The Behaviour Change Taxonomy (Michie et al. 2013) classifies the techniques used in the interventions as including: BCT 7.1 Prompts/cues; BCT 5.3 Information about social and environmental consequences; and BCT 9.1 Credible Source.

5.5.3 Control (CONTROL)

No messages were sent to participants in the Control group.

5.6 Technical implementation

A web-based database application was developed using the Ruby on Rails[2] framework and hosted on the Heroku[3] web hosting platform. The Twilio[4] web service was used to deliver messages and validate cell phone numbers. See Figure 7.

The application allowed office staff to log in with individual passwords to manage students' class enrolments, cell phone numbers and family members' details. Because of the flexible nature of the school, office staff and the researcher also had to check participants' schedules each day and ensure that the application database contained an accurate count of how many classes each participant was enrolled in. Connections were encrypted with an SSL certificate for security. Participants' information was added to the application and then they were automatically assigned to experimental groups in a pseudo random process described above. The application confirmed, using a service from Twilio that the cell phone number given was not a landline and, in the event that it was, the participant was asked again for a valid cell phone number.

[2] http://rubyonrails.org/
[3] https://www.heroku.com
[4] https://www.twilio.com/

Participants' attendance records were downloaded each day from the school attendance database as Excel spreadsheets and uploaded to the application database which reformatted the data to allow for more efficient querying.

For more detailed implementation see Appendix 11.2.1.

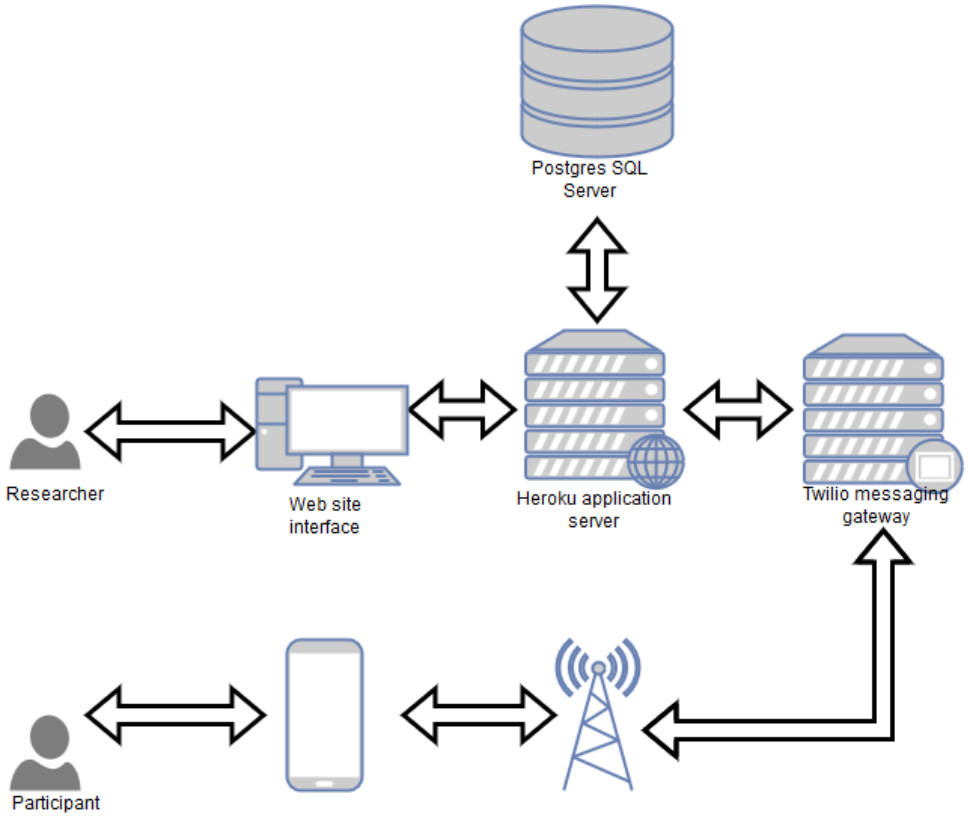


Figure 7: Application components

5.7 Summary

This chapter has drawn from reviews of research into school absenteeism, theories of behaviour change and reported computer driven behaviour change interventions delivered by text message. These inputs formed the foundations of two theory-based intervention conditions for evaluation aimed at supporting school attendance among at-risk youth. The research design also provided opportunities to understand the effective components of interventions delivered by SMS.

The intervention content focuses either on developing self-efficacy through positively phrased, adaptive supports and praise when participants are performing well (group ADAPT, based on Social Cognitive Theory) or delivering a series of information and motivational quotations to increase their intentions to attend school more regularly (group SERIES based on the Theory of Planned Behaviour).

The effectiveness of these interventions will be compared with each other and with a no treatment control in order to identify the most effective components for behaviour change in this context. Because the intervention conditions have been developed based on theory, it is hoped that the results will be more generalisable to other contexts and populations than if they were not.

6 Pilot trial

6.1 Introduction

The goal of the pilot study was primarily to test the technological systems and recruitment procedure and to informal gauge participant responses to the intervention. It was hypothesized that messages containing adaptive feedback (group ADAPT) on attendance would reduce absenteeism when compared to a control group receiving no messages. A secondary hypothesis was made that this group would also miss less school when compared to a third group receiving a series of prescribed messages chosen at random containing information about the importance of regular school attendance and motivational quotations (group SERIES). Additional feasibility trials were undertaken of interactive polls and the inclusion of messages to family members and informal feedback was gathered from participants about the intervention.

6.2 Methods

6.2.1 Research design

A three-armed parallel, single blind, pre-post-control experimental design was used (see Figure 8). Collection of attendance data before the intervention enabled confirmation investigation of the equivalence of the groups' attendance. Participants were randomly assigned to one of three groups and their attendance behaviours compared. Together with a no treatment CONTROL group, two levels of messages were sent; for one group messages were adaptively tailored to participants' individual, recent attendance behaviours (ADAPT); the other group received randomly selected reminder messages stressing the importance of regular school attendance or motivational quotations (SERIES). Detailed descriptions of these treatments are provided below.

Because the frequency of messages sent to participants in the ADAPT group would depend on their behaviour, participants in the treatment groups (ADAPT and SERIES) were yoked in pairs to control for message frequency. For example, whenever participant A in the ADAPT group was sent a message,

participant A in the SERIES group would also receive a message. Participant A in the SERIES group would not receive any messages unless their yoked participant in the ADAPT group was sent a message.

Messages were sent from 19 October 2015 to 17 December 2015.

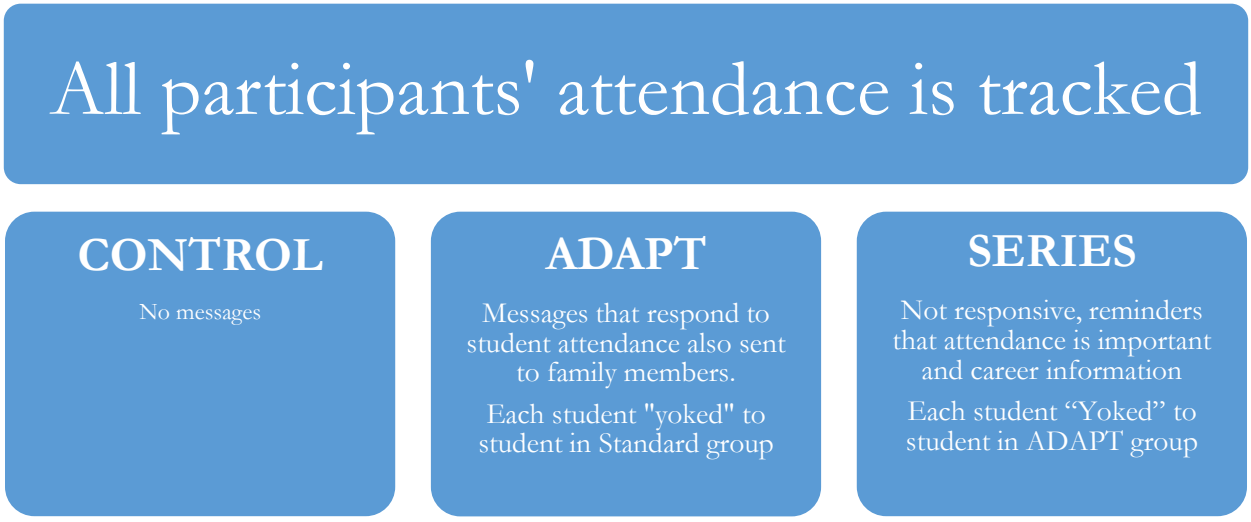


Figure 8: Pilot Trial – Treatment of groups

6.2.1.1 Participant characteristics

The sample in this study (N=24) included 12 male and 12 female, aged between 15 and 20 years who were recruited at an "alternative" high school in Texas, USA, a label that describes a school with no more than 250 students, small class sizes, an individualized learning program, flexible schedule and "a commitment to every student being successful" (National Dropout Prevention Center 2016).

Overall, the sample was comprised of students from a low socioeconomic status background. The majority (71%) of participants were classified as economically disadvantaged. This was defined according to the common convention in US based educational research, being whether or not they received a free or subsidised lunch under the Federal Lunch Program (USDA 2016). This program partially subsidizes lunch for those students in homes with an income between 130% and 185% of the Federal Poverty Level, which in turn depends on the size of the household and its income (Federal Register 2016). Those students coming from homes with an income below 130% of the poverty level

receive free school lunch. Households receiving other financial supports may also qualify. Its use as an indicator of social economic status has been validated against other, community observation based indicators and found to be significantly associated with family poverty (r=0.67) and household income (r=-0.60) (Nicholson et al. 2014). 88.1% of participants received free lunch and 8.96% received subsidized lunch. All participants were labelled as "at-risk" of not graduating according to the Texas Education Authority definition (Texas Education Code 2013).

6.2.1.2 Sampling

A convenience sample was used; students were invited to participate while enrolling at the school between August and September 2015. The selection of students who were offered to take part was quasi-random; there was no specific selection technique but there was an element of convenience in the very busy environment that was the school office at the start of the year. Participation was voluntary and no incentives were offered. Students were told that they were being invited to participate in a research project that was completely voluntary and that they could withdraw from it at any time by telling the researcher or the office staff and that they could stop receiving messages simply by responding STOP to the messages that they received. Students signed a consent form and provided their own cell phone number to indicate that they wished to participate. They were also asked to list the cell phone numbers of family members to whom they would like messages about their successes to be sent.

6.2.1.3 Random assignment method

After participants were recruited and had signed consent forms, they were randomly assigned to one of three groups with students in the two treatment groups “yoked” by a computer program as follows. One student unassigned participant was selected at random and assigned to the ADAPT group. A second participant was selected at random, assigned to the SERIES group and “yoked” to the student that had just been assigned to the ADAPT group. A third student was selected at random and assigned to the CONTROL group. If there were at least three unassigned students remaining, the process repeated. If not, the remaining students were not assigned to any group and did not participate in the study.

6.2.1.4 Ethical approval

The school principal, as gatekeeper, gave consent for the study to take place. Ethical approval by Coventry University was obtained before starting the study. Students signed a consent form and provided their own cell phone number to indicate that they consented to participate.

6.2.2 Measures

The primary measure was the attendance status of each student taken by teachers each period of the school day as part of their general routine and was collected daily from the school attendance database. Because some students were only required to attend a partial schedule (for example 3 out of 7 periods per day) for some or all of the intervention period, each student's percentage attendance rate was calculated for each day:

% = (number of periods attended / number of periods enrolled) x 100

Students' mean attendance rate was then calculated before and after the date that messages started to be sent (16 October 2015) up until the last day of the intervention (17 December 2015).

6.2.3 Demographics

School records were used to collect data on participants' gender, age, race, grade level (class), socio-economic status, receipt of special education services, classification as at-risk, years since being identified as at-risk, years since entering 9th grade (starting high school), home language, primary language, and whether or not they rode the bus. While this pilot study was not powered to detect any moderating effects, the data was collected in order to gauge feasibility for the following evaluations. See Table 9.

	All	ADAPT	SERIES	Control
	N (%) or M (SD)			
N	22 (100%)	7 (100%)	7 (100%)	8 (100%)
Sex				
Male	11 (50%)	5 (71%)	3 (43%)	3 (38%)
Female	11 (50%)	2 (29%)	4 (57%)	5 (63%)
Age (years)				
< 18:	17 (77%)	4 (57%)	6 (86%)	7 (88%)
>= 18:	5 (23%)	3 (43%)	1 (14%)	1 (13%)
Federally identified race				
American Indian or Alaskan Native	5 (23%)	2 (29%)	1 (14%)	2 (25%)
American Indian or Alaskan Native/White	1 (5%)	0 (0%)	0 (%)	1 (13%)
Black or African American	4 (18%)	2 (29%)	1 (14%)	1 (13%)
White	12 (55%)	3 (43%)	5 (71%)	4 (50%)
Hispanic/Latino				
Yes	18 (83%)	5 (71%)	6 (86%)	7 (88%)
No	4 (18%)	2 (29%)	1 (14%)	1 (13%)
Low socioeconomic status				
Yes	15 (68%)	4 (57%)	4 (57%)	7 (88%)
Free lunch	10 (45%)	2 (29%)	3 (43%)	5 (63%)
Reduced price lunch	5 (23%)	2 (29%)	1 (14%)	2 (25%)
No	7 (32%)	3 (43%)	3 (43%)	1 (13%)
Receiving special education services				
Yes	0 (0%)	0 (0%)	0 (0%)	0 (0%)
No	22 (100%)	7 (100%)	7 (100%)	8 (100%)
At risk				
Yes	22 (100%)	7 (100%)	7 (100%)	8 (100%)
No	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Years since identification as at risk	2.18 (1.68)	2.41 (2.01)	1.47 (1.38)	2.60 (1.61)
Years since entering 9th grade	2.38 (0.980)	3.00 (0.636)	2.01 (1.43)	2.25 (0.462)
Riding the bus				
Yes	7 (32%)	1 (14%)	5 (71%)	1 (13%)
No	15 (68%)	6 (86%)	2 (29%)	7 (88%)
Home language				
English	11 (50%)	6 (86%)	3 (43%)	2 (25%)
Spanish	11 (50%)	1 (14%)	4 (57%)	6 (75%)
Primary language				
English	11 (50%)	6 (86%)	3 (43%)	2 (25%)
Spanish	11 (50%)	1 (14%)	4 (57%)	6 (75%)

Table 9: Pilot Trial - Participant characteristics

6.3 Results

6.3.1 Participant flow

Two participants asked to stop receiving messages and exit the study. The first asked immediately after the first message was sent and the second asked after a few weeks. Two students withdrew from the school to attend elsewhere and one student graduated. The two students that asked to withdraw from the study were not included in the analysis. The three students that left the school were included in the analysis for the time that they were enrolled See Figure 9.

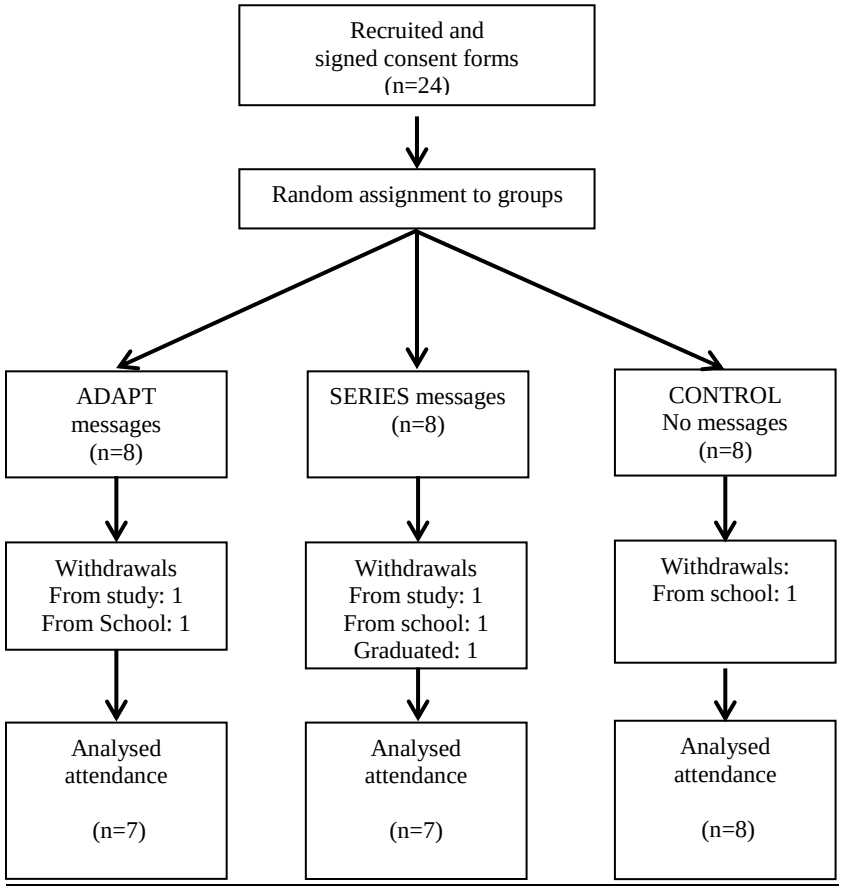


Figure 9: Pilot Trial – CONSORT 2010 Flow of participants

6.3.1.1 Treatment fidelity

The main purpose of this trial was to evaluate the software application, message delivery and receipt system, to explore the acceptability of the messages to the students, to address technical problems

and establish the feasibility of carrying out a larger study. There were some technical delays in implementing messages to family members and the weekly poll. All messages regarding attendance were delivered to participants as described.

6.3.2 Main effect

This pilot study was not powered to detect differences between experimental groups. Figure 10 shows how the attendance rate varied across groups once delivery of the intervention began (see Table 10 for numeric data).

	Mean attendance rate (standard deviation) mean of daily attendance = (periods attended / periods enrolled) x 100	
	Before sending messages	**After sending messages**
CONTROL	92 (22)	81 (37)
ADAPT	87 (29)	85 (31)
SERIES	88 (29)	83 (30)

Table 10: Pilot Trial – Attendance rates

The attendance rate of the CONTROL group fell over time from a mean of 92% to 81%. The attendance rate in the two intervention groups started lower, fell less and remained above the CONTROL group's attendance rate at the end of the study. The ADAPT group showed the smallest fall in attendance.

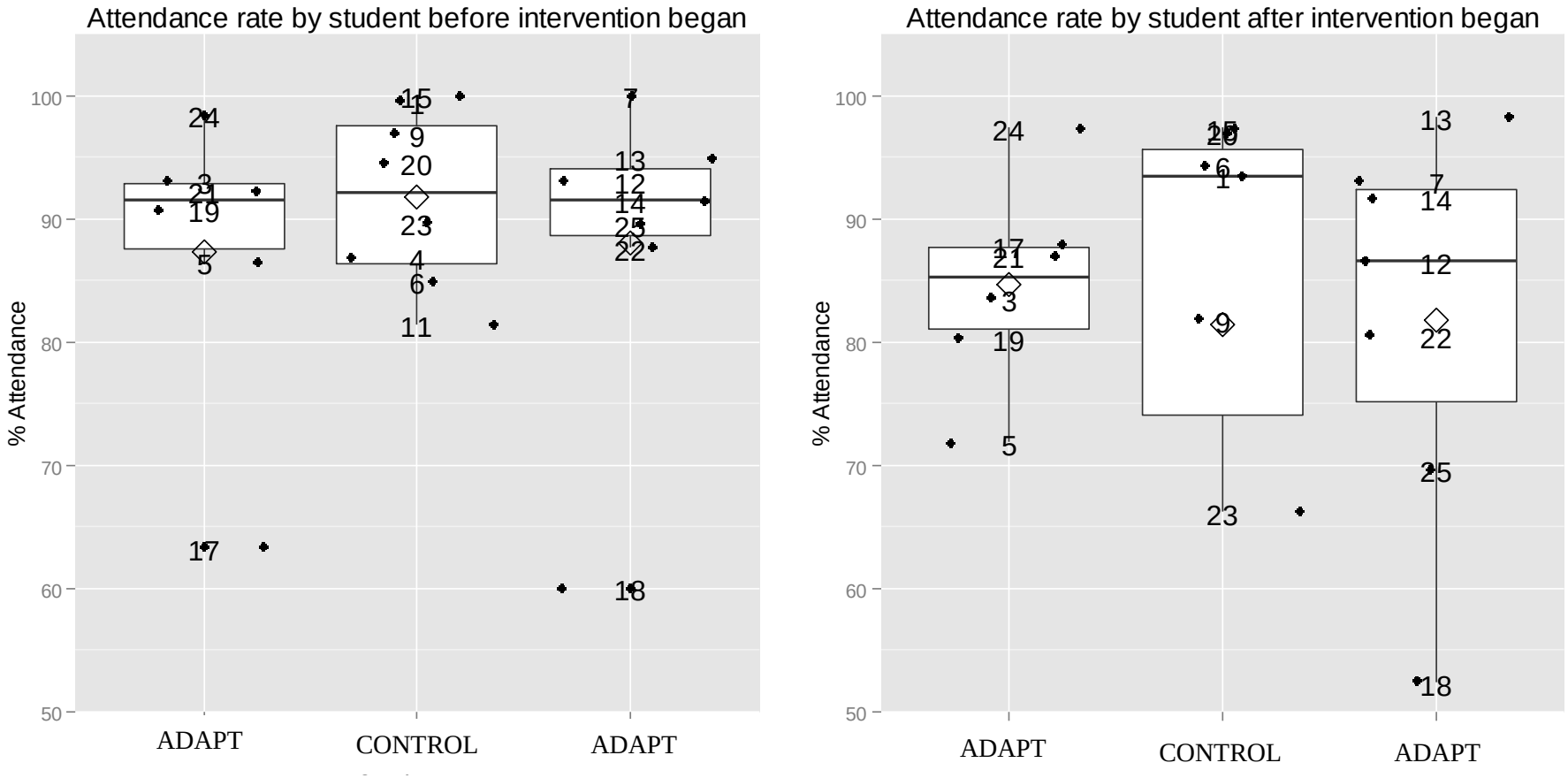


Figure 10: Pilot study – Attendance rate by student before and after the intervention

- Numbered participant

◊ Mean value

6.3.3 Weekly Poll

The weekly poll asking "how much do you want to go to school this week?" and described further in section 5.4, was only distributed in the last four weeks of the study. While response rates were generally low, the group receiving adaptive messages responded more often, which may suggest greater engagement with the intervention (see Table 11).

Date	ADAPT		SERIES	
	Response rate	Mean score	Response rate	Mean score
November 17	3/6	8.3	2/7	10
December 2	2/6	10	0/6	-
December 8	3/6	7.7	1/6	10
December 15	1/6	10	1/6	9

Table 11: Pilot Trial – Response to weekly poll

6.3.4 Informal interviews and acceptability of the intervention

Informal interviews with participants found generally positive views of the messages received. A student in the SERIES group found the messages "inspirational" and felt that they helped her come to school. One student in the ADAPT group found that they were a helpful way to keep track of how well he was doing coming to school and another said that he forwarded them to his mother to show how well he was doing and as prompts to work with the attendance clerk to fix errors in his attendance record. No participants had received any feedback from family members who had received messages about their attendance and were indifferent to this component of the intervention. Some participants explained that they had shown or forwarded the messages that they had received to their families when they were being successful. There were some negative responses, one student in the ADAPT group said that he did not like the messages that congratulated him for three days attendance by saying "let's make it five!".

Another student in the ADAPT group withdrew from the study after he received a message for the 3rd time noticing that he had come to school late and asking if he was interested in a wake-up call:

"Well done for coming to school today. Would you be interested in getting a wakeup call or text? Answer WAKEUP for more information." He asked to stop receiving the messages and was withdrawn from the study. Upon asking if he had any feedback on the message intervention he only stated that it was "boring".

6.3.5 Technical feasibility

The application successfully processed all attendance data uploaded to it from the school attendance system and saved it correctly in the database and the database structure proved suitable to recover the information needed for both the message delivery and subsequent analysis. The Weekly Poll proved to be feasible with participant responses to the prompt being correctly recorded. Callback confirmation notices were received from the Twilio service confirming that all messages had been sent to participants' devices.

The pilot project showed that sending individualised text messages based on attendance behaviours with yoked control messages sent to individuals in a second experimental group could be achieved with a high degree of automaticity and at low cost. The results indicate that the author's hypothesis that messages that comprising both adaptive feedback and messages with information about school attendance may be more effective than no treatment.

The pilot trial also showed that it would not be possible for the researcher to keep the number of periods for which students were enrolled up to date reliably by hand and that an automated system was required. This was due to the flexible nature of the school in which the research was undertaken where students may complete classes at any time, and may opt for part day schedules rather than be scheduled for seven classes every day. During this pilot trial the researcher manually checked each students schedule and updated a variable in their profile to reflect the number of classes for which they were scheduled. This would prove onerous with a large sample of participants and an automated method was required before a larger sample size could be evaluated.

Some of the participants in the ADAPT group reported using messages as prompts to approach the attendance office to correct their attendance record when they did not agree with the feedback that they received. The application did not record how often attendance records were amended and so a logging feature was added for the future evaluation studies.

6.4 Discussion of findings

The pilot trial proved the delivery of SMS messages generated automatically from the school attendance database to participants to be technically feasible. Also, two-way messages were found to be feasible and a Weekly Poll was completed by some participants though the rate of participation was low (see section 5.5). Insufficient participants were recruited to power a statistically significant test of changes or differences in attendance rates but the trial demonstrated that such measurements could be made and analysed from the application. Trends in the data suggest that both conditions of the intervention may have supported attendance rates and that the ADAPT intervention may have been more effective.

The application operated with little user input to send messages and could be adapted to operate entirely automatically with the only input needed from administrators being the addition of new students, updating of contact details and general supervision and a single instance could provide support to 1000s of students at low cost.

Comments from participants were mainly enthusiastic though suggested that while some participants found the intervention to be positive, others were annoyed by it and did not like it. A review of the theories implemented suggested that their comments may reflect the negative effect of imposing goals on people as suggested by Self Determination Theory. It is also possible that praise may be phrased in such a way as to be perceived controlling by the recipient (Henderlong and Lepper 2002). To address this, a further review of literature surrounding the scripting of autonomy supporting messages was made (see section 6.5.1 below) and new autonomy supporting messages composed.

6.5 Changes to the experimental protocol

The findings of the pilot led to new hypotheses. While both intervention conditions may have increased attendance, participants receiving the adaptive messages voiced dissatisfaction with them the most and in particular disliked messages that pushed them ("let's make it five", "would you be interested in getting a wakeup call?"). Because perceived autonomy has previously been found to correlate with school dropout (Vallerand et al. 1997), it was hypothesised that messages containing feedback on attendance together with autonomy supporting messages would be most effective at reducing unexcused absences from school.

A rules matrix of messages aimed at supporting student autonomy was created based on a review of the literature (see Appendix 11.4). It combined non-controlling and context appropriate praise that was linked to recent attendance together with the informational and motivation quotations previously used in the SERIES group in the pilot trial. The selection of quotations and pieces of information was modelled on the Theory of Planned Behaviour to shape recipients' intention to attend by modifying their perception of value of attending school (with statistics about attendance), by reshaping their perceptions of social norms (with information about careers) and by boosting their perceived motivational control over their behaviour (with motivational quotations). Some of the messages contained only the informational or motivational quotations.

It was further hypothesized that participants receiving the feedback with autonomy supporting messages would have lower rates of absenteeism than those receiving only feedback on attendance, the autonomy supporting messages being key to the attendance support.

In order to maximise exposure to the intervention, messages were sent to all participants in the experimental groups on each school day. This also removed the need for yoking participants. Messages to family members were discontinued because pilot participants were indifferent to their use and said that they would show the messages to their family when they wanted to. Informal feedback from the Pilot

study suggested that some participants found the messages controlling and de-motivating. This led to a re-examination of the intervention design and changed the focus of the messages from building self-efficacy to include autonomy support.

6.5.1 Scripting autonomy supporting messages

In a study encouraging physical activity among university students (Kinnafick et al. 2016), the authors recommend themes for messages relating to each of the three aspects of SDT as described in Table 12 below:

Autonomy	• Providing information as a meaningful rationale • Enhance perceptions of value of activity • Provision of choice and variety • Facilitating enjoyment
Relatedness	• Social support: trusting and feeling connected to others • Portray respect, understanding and care • Acknowledge negative feelings associated regarding the activity
Competence	• Supporting confidence by providing information and relevant feedback • Help setting challenging but realistic goals • Advice on resisting and overcoming barriers • Focus on intrinsic goals i.e., health, personal growth

Table 12: Guidance for writing messages to support each aspect of SDT (Kinnafick et al, 2016)

In a published protocol describing an intervention to promote physical activity among teenagers, researchers piloted SDT based text messages with a sample of participants and collected their feedback on message content (Thompson et al. 2014). Students suggested that messages should be short, positive and

realistic ("*Your steps, your choice, your life! You're in charge!*", "*You are capable of using strategies to reach your step goal! Success is yours!*", "*Meeting your step goal shows you know how to achieve your goals, like getting good grades.*"). They should avoid nagging or "sounding like school" and should not use phrases like "brain storming" and "problem solving". Also, they should include emoticons or exclamation marks to convey emotions and avoid using abbreviations like "GR8" for "great". Other studies have found that emoji or emoticons can add meaning and emotion to text messages (Huang et al. 2008, Jibril and Abdullah 2013, Kelly and Watts 2015) and identified a need for SMS messages to be written in an informal style documented in a study that found that adding full stop or period to the end of an SMS message would lead to the recipient rating than message as less sincere than the same message without (Gunraj et al. 2016).

In a study that sent messages to obese adolescents to help them lose weight, the students gave the following feedback on message format and content (Woolford et al. 2011). As above, emoji and exclamation points were felt to be important; messages should be positive and encouraging but realistic – do not over praise. They preferred informational messages that provided them with instructions such as recipe ideas (*"Think of ways to make fruits and vegetables more interesting. Freeze your grapes. Steam your carrots w/ spices Add peanut butter and raisins to your celery"*), anecdotes of how others had lost weight (*"One teen said, 'Exercise was boring until I started walking at the mall with my friend. It is fun to walk and window shop'"*), tips for weight loss (*"Your goal is at least five veggies and fruit a day. That's about 2.5 cups. Have half a cup at breakfast, 1 cup at lunch, and 1 cup at dinner"*). They did not like messages that encouraged reflection, asked lots of questions, or were not directional (*"What interests you? Cutting back on screen time may make room for a new hobby. If it's active, great. If not, it's still good to get away from the screen"*).

6.5.2 Intervention groups: Graphical feedback only (GRAPHICAL)

To avoid controlling language in giving feedback on attendance, a graphical feedback device similar to a scoreboard in a video game was used to communicate recent attendance performance in both

groups. Participants received an MMS message containing the text "This is your attendance record today" together with a graphical representation of their recent attendance behaviours. The image displayed the participant's recent attendance in three circular graphics, the first showing their attendance over that day's seven class periods, the next showing their attendance that week and the outside showing their attendance over the course of the calendar month. Where participants were not enrolled for all seven periods or when there was no school due to holiday or other reason, sections were shown in white.

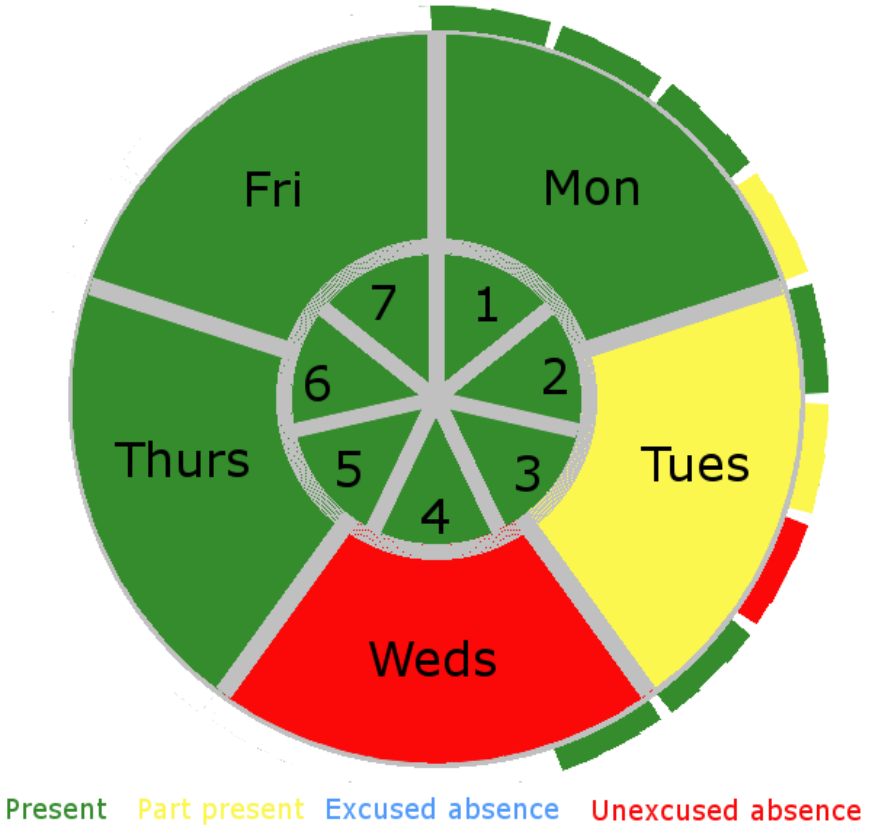


Figure 11: Example attendance graphic

The example graphic in Figure 11 would have been sent on a Friday. It shows that the student was present for all seven of the day (centre circle in green), was present for all classes on Monday, Thursday and Thursday (green segments in second circle), was absent all day on Wednesday (red segment), was partially present on Tuesday (yellow segment). The outermost ring displays attendance for each school day in the present calendar month.

A set of on-boarding messages was sent to participants at the start of the intervention which sent their first attendance graphic in three stages together with an explanation of each ring. First, the centre ring with just that day's attendance, then the second ring was added and finally the whole graphic was sent. Messages were sent 30 seconds apart.

6.5.3 Intervention groups: Graphical Feedback + Autonomy supporting text (GRPH+AUTMY)

Participants received the same graphic as group GRAPHICAL and received additional text tailored to their recent behaviours. The rules matrix in Appendix 11.4 details how the accompanying message was chosen based on the following variables:

- Present today – attended at least one scheduled class today
- Present yesterday – attended at least one scheduled class on the previous school day
- Present day before yesterday – attended at least one scheduled class two school days previously
- Unexcused today – did not attend any classes today and no excused absence listed
- Excused today – did not attend any classes today and all periods missed are marked as excused absences
- Perfect attendance today – attended all scheduled classes today
- Days at school – most recent number of consecutive school days that they attended at least one scheduled class
- Days perfect attendance - most recent number of consecutive school days that they attended all of their scheduled classes
- Proportion at school – the number of days that they were present for at least one scheduled class in the last fifteen school days divided by 15. If attendance data is not available for 15 days, the number of days that attendance data is available was used.

The message templates in the rules matrix (see appendix 11.4) contain markers for text insertions comprising career information ("[careers]"), college information ("[ed info]") and motivational quotations ("[keep going]", "[get up]", and "[love yourself]") from celebrities (see appendix 11.5). To avoid repetition of messages, each time a quotation or piece of information was provided, a list of quotations that had not been sent to that individual student was generated and an item selected at random. Once all items had been sent to a student, the random selection restarted, sending the items that had been sent the least. Emoticon were also added to the message according to tags in "< >", for example: "smiley"  , "smirk"  , "persevere"  , "thinking"  , "phone"  , "ambulance"  , "sick"  , "highvoltage"  , "sleepy"  , "construction"  , "hospital"  , "rolling eyes"  , "wink"  , "ok"  , "briefcase"  , "computer"  , "auto"  , "money"  , "hammer"  . See Appendix 11.6 for a full list. The images in this paper are the black and white chart representation of the emoji Unicode; the images displayed vary according to the device on which they are displayed[5].

6.5.4 Changes to technical implementation

Changes were made to the application to generate the attendance graphic and to implement a more complex rules system for message composition. Because keeping an accurate daily count of class enrolments would have been too onerous with a larger sample size, the application was modified to track participant enrolment daily from the school attendance system. A logging system was implemented to track corrections made to participants' attendance records for analysis. For futher information see Appendix 11.2.2.

[5] For a full listing of UNICODE emoji together with their appearance on different devices see http://unicode.org/emoji/charts/full-emoji-list.html.

6.6 Summary

This chapter describes the first trial of school attendance supports among at-risk youth through a low cost, scalable intervention delivering individually tailored SMS messages to students. The trial showed that the intervention was technologically feasible and that students found it to be acceptable, many expressing that they enjoyed receiving the messages. While the evaluation was not powered to detect significant effects of the intervention, summary statistics suggest that the messages may have supported rates of attendance while they fell in the control group that did not received any messages.

Some weaknesses in the original protocol were identified. First, further automation of the management of student enrolments was needed to avoid management of the intervention becoming onerous. Interviews with students suggest that some of the messages sent were perceived to be controlling and further study of the literature suggested focussing the study on the effect of autonomy supporting messages on attendance. The development of the intervention has been described and the following chapters report on its evaluation.

7 Study One: An evaluation of an SMS-based autonomy supporting feedback intervention on school attendance rates

7.1 Introduction

This research set out to design an intervention to support school attendance among at risk youth that could be delivered by SMS message and therefore be implemented at low cost and large scale. Furthermore, the research aims to develop our understanding of designing SMS driven behaviour change interventions by applying theory in the development and evaluation of the intervention. The Study Protocol (chapter 5) and Pilot Study (chapter 6) describe the application of findings from the literature and experience to design the intervention to be evaluated (see section 6.5).

In this chapter, the effect of autonomy supporting praise and feedback on recent school attendance is evaluated. Daily messages consisting of graphical feedback of school attendance together with autonomy supporting text by SMS were evaluated against a control group and against an intervention consisting of only the graphical feedback. Messages were sent within two hours of the end of the school day and commented on that day's attendance.

The thesis behind this research is that SMS messages can improve school attendance among at-risk youth in a similar way to counselling classes, contingency contracting and rewards systems. Comments from participants in a pilot trial (chapter 6) suggested that they found messages consisting of only text that consisted of praise to be over controlling and 2 participants (out of 16 that received messages, 12.5%) asked to stop receiving the messages.

It was hypothesized that because perceived autonomy correlated with school dropout (Vallerand et al. 1997), messages containing graphical feedback on attendance together with autonomy supporting messages would reduce unexcused absences from school. A database of messages aimed at supporting student autonomy was created which combined non-controlling and appropriate praise (based on Self

Determination Theory, see section 6.5.1) that was linked to recent attendance together with the informational and motivation quotations previously used in the pilot trial (based on the Theory of Planned Behaviour). Some of the messages contained only the informational or motivational quotations. It was further hypothesized that participants receiving only the feedback on attendance would have a lower rate of attendance than those also receiving the autonomy supporting text.

This study tests the following hypotheses:

1. Sending graphical feedback on recent attendance to students by SMS will increase attendance rates when compared to a no message control group.
2. Sending graphical feedback together with autonomy supporting messages will increase attendance rates when compared with sending only graphical feedback and with a no message control group.
3. Sending autonomy supporting messages will increase perceived autonomy of recipients when compared to sending feedback only messages and with a no message control group.

7.2 Method

7.2.1 Research design

A three-armed parallel, single blind, pre-post-control experimental design was chosen. Two experimental groups, one that received only graphical feedback on attendance (GRAPHICAL) and one that received the same graphical feedback together with autonomy supporting text (GRPH+AUTMY). These were compared with a CONTROL group that received no text messages.

The primary measure was of school attendance, the proportion of full days missed with unexcused absences, the proportion of days with no unexcused absences and the proportion of classes missed with unexcused absences. Secondary measures of mood, self-esteem, perceived autonomy, stage of change were made with questionnaires before and after the intervention was delivered. Acceptability questionnaires were completed by participants receiving messages.

7.2.1.1 Participant characteristics

The sample in this study (N=76) included 44 male and 32 female students, aged between 15 and 20 years who were recruited from the same school as in the Pilot Trial. Nearly all (97%) of participants were classified as economically disadvantaged, 88% received free lunch, 11% reduced lunch and 98.5% were labelled as 'at-risk'. See section 6.2.1.1 for explanations of "economically disadvantaged, "at-risk" and details surrounding free and reduce price lunch.

7.2.1.2 Sampling

A convenience sample was used; students were invited to participate while enrolling at the school, during school assemblies, classes and at lunchtime through announcements and individual invitations from the researcher, teachers and school staff. Students were told that they were being invited to participate in a research project that was completely voluntary and that they could withdraw from at any time by telling the researcher or the office staff and that they could stop receiving messages simply by responding STOP to the messages that they received. A cell phone charger was offered as an incentive upon completion of the first set of measures and a $10 gift card at the end of the study. Participants were warned before agreeing to participate, that depending on their cell phone contract, they may be charged to receive messages. Students signed a consent form and provided their own cell phone number to indicate that they wished to participate. Participants were recruited from 28 March 2016 to 12 May 2016.

7.2.1.3 Inclusion and exclusion criteria

Eligibility criteria were enrolment at the school for at least part of each school day and that participants must have a cell phone on which they could receive text messages. Participants were only excluded if they did not have a cell phone that could receive messages.

7.2.1.4 Random assignment method

Each time that new students were added to the intervention, they were assigned to groups by simple randomization by the software application. The software selected all students who were not

already assigned to an intervention group. For each student, the software generated a random number (0,1, or 2) and assigned the student to one of three groups respectively, GRAPHICAL (graphical feedback only), GRPH+AUTMY (graphical feedback + autonomy support) and CONTROL (no messages).

7.2.1.5 Ethical approval

The school principal, as gatekeeper, gave consent for the study to take place. Ethical approval by Coventry University was obtained before starting the study. Students signed a consent form and provided their own cell phone number to indicate that they consented to participate.

7.2.2 Measures

7.2.2.1 Attendance

The study's main outcome measure was student attendance. Attendance is routinely recorded by classroom teachers for each student in each class period that students are scheduled to attend; in most cases this is 7 periods per day, with shortened schedules for students with work commitments or those who are nearing graduation. Attendance is recorded on a school-wide computer system and a full-time Attendance Clerk ensures its accuracy and documents any reasons that students may have for *excused absences* (for example, sickness or court appearances). For the purposes of this study, students marked tardy were considered to be present and because the intervention was targeted at students' choice to attend school (rather than other factors that may lead them to miss school with an excused absence) only unexcused absences were examined.

Because the intention was to help participants reflect on their attendance behaviours, feedback was designed to respond positively to their attending school for even part of a day with special recognition of perfect (full day) attendance. The attendance intervention literature is not always clear on how attendance is measured (see discussion in section 2.6.5) so in order to allow comparison with future studies attendance was measured in three ways: as a percentage of days with no missed periods, as a

percentage of days when students attended for at least part of the day, and as a percentage of classes missed.

Student attendance was coded in four ways for each day that each student was enrolled.

- Whole days missed (unexcused) – where a student was absent for every one of the classes in which they were enrolled and the absences were coded as unexcused
- Day with no unexcused absences – where a student was either present for all classes in which they were enrolled or was coded as having an excused absence for any class periods that they were not present
- Percentage of scheduled classes missed - the number of classes that a student missed in a day that were coded as unexcused absences expressed as a percentage of the number of classes for which the student was scheduled that day.

7.2.2.2 Secondary measures used in Study One and Two

It was hypothesised that perceived autonomy would mediate the interventions effect on attendance, with participants receiving autonomy supporting messages having higher perceived autonomy in school and in turn, lower rates of absence. The literature review (section 2.5.4) also suggested that school attendance was linked to self-esteem and mood (specifically anxiety). To this end, self-report measures of mood, self-esteem and perceived autonomy in school were taken before and after the intervention and are described below. Because the intervention design adopted principles of the Transtheoretical Model and tailored messages according to how regularly students attended, a measure of stage of change was adapted for this study (see Truancy Ladder, section 7.2.2.2.4). An acceptability measure was developed based on similar published studies and completed by both intervention groups at the end of the study (see section 7.2.2.2.5).

Copies are included in Appendix 11.7. They were administered only in English in Study One.

7.2.2.2.1 Mood

Mood was measured with a short form of the Profile of Mood States measure (McNair et al. 1971), a 65 item questionnaire designed for use with participants over 18 years old. The measure used was the standard short form that consists of 24 items and has been validated for use with adolescents with Cronbach alpha > 0.74 to 0.90 for measures of Anger, Confusion, Depression, Fatigue, Tension and Vigour among school children aged 14-16 (Terry et al. 1999). A copy of the measure used is included in Appendix 11.7.

7.2.2.2.2 Single item self esteem

A shortened, single item self-esteem measure of the ten item Rosenburg Self-Esteem Scale (Rosenberg 1989) was used to measure self-esteem. It has been shown to be a valid and reliable measure when compared to the ten item Rosenburg instrument when it was validated using the Heise (1969) procedure and was found to have similar reliability to the Rosenburg Self-Esteem Scale (Robins et al. 2001). A copy of the measure used is included in Appendix 11.7.

7.2.2.2.3 Perceived Student Autonomy in education

Students' perceived autonomy at school was measured using the short form of the Learning Climate Questionnaire (Selfdeterminationtheory.org 2017, Deci et al. 1989, Williams et al. 1996, Williams and Deci 1996). As recommended in the instrument documentation, items were amended to refer to "my school" rather than "my instructor". A copy of the measure used is included in Appendix 11.7.

7.2.2.2.4 Truancy Ladder

The Truancy Ladder was constructed for use in this study and was based on the Marijuana Ladder, an instrument designed to identify the stage of change of adolescent marijuana users in detention (Slavet et al. 2006) .

	Patient stage (Zimmerman 2000)	Contemplation ladder (Biener and Abrams 1991)	Marijuana Ladder (Slavet et al. 2006, Biener and Abrams 1991)	"Truancy Ladder"
Maintenance	Maintaining new behaviour over time	Taking action to quit (e.g. cutting down, enrolling in a program)	I have changed my marijuana use and will never go back to the way I used marijuana before.	I'm going to school a lot now and I'm never going to skip again.
Action	Taking a definitive action to change		I have changed my marijuana use, but I still worry about slipping back, so I need to keep working on the changes I've made.	I'm going to school a lot now but I'm worried I might start skipping again
Preparation	Experimenting with small changes	Starting to think about how to change my smoking patterns	I plan on using marijuana after release. But I'll make some changes, like cutting back on the amount of marijuana that I use.	I want to go to school more and I'm going to start going more now
		Think I should quit but not quite ready	After release I definitely plan to change my marijuana use, and I'm almost ready to make some plans about how to change	I'm definitely going to start going to school regularly and I'm almost ready to make some plans about how to change
Contemplation	Weighing benefits and costs of behaviour, proposed change		After release I definitely plan to change my marijuana use, but I'm not ready to make any plans about how to change.	I'm definitely going to start going to school regularly but I'm not ready to make any plans about how to change
		Think I need to consider quitting someday	I often think about the way that I use marijuana, but I have no plans to change it;	I often think about having perfect attendance but don't have any plans to do it
			I sometimes think about the way that I use marijuana, but I have no plans to change it;	I know going to school would be good for me but I don't plan to
Pre-contemplation	Not thinking about change May be resigned Feeling of no control Denial: does not believe it applies to self Believes consequences are not serious		I rarely think about changing my marijuana use, and I have no plans to change it.	I go to school because the law makes me but I don't plan to go regularly.
			I never think about changing the way that I use marijuana, and I have no plans to change;	I don't plan to go to school regularly. I don't need to.
		No thought of quitting	I enjoy using marijuana and have decided never to change it. I have no interest in changing the way that I use marijuana;	I'm not going to school. School's not for me.

Table 13: Development of Truancy Ladder: Comparison of validated measures for stage of change and their translation for use in measuring stage of change in attendance behaviour

The Marijuana Ladder was found to correlate with self-reported marijuana use and participation in treatment programs. The marijuana ladder was adapted from the Contemplation Ladder, an instrument that measured the stage of change of smokers with regard to smoking cessation which found that scores correlated with reported intention to quit and predicted participation in smoking cessation education programs (Biener and Abrams 1991).

The Truancy Ladder also builds on descriptions of each stage of change as described in an article detailing the development of a stage of change assessment instrument for more general heath improvement behaviour change (Zimmerman 2000). Table 13 aligns components from these three sources with items constructed for the Truancy Ladder. A copy of the measure used is included in Appendix 11.7.

7.2.2.2.5 Intervention Acceptability

An acceptability measure was developed based on similar reported measures of other SMS based interventions (da Costa et al. 2012, Franklin et al. 2006, Castaño et al. 2012, Mbuagbaw et al. 2012, Boker et al. 2012, Vervloet et al. 2012, Hou et al. 2010, Lester et al. 2010, Pena-Robichaux et al. 2010, Granholm et al. 2012, Hardy et al. 2011, Ollivier et al. 2009, Suffoletto et al. 2012a, Dick et al. 2011, Dowshen et al. 2012). Table 14 lists topics and example items used to formulate the questionnaire items including topics of how useful of help the messages were, participants' perceptions of improved performance as a result of the intervention, intrusiveness, and participant satisfaction with message content, number, length, timing and whether they would recommend the intervention to others. These items were incorporated into the acceptability measure.

In addition to asking students for their perceptions of the intervention, two open-ended, free response questions were included in the questionnaire: "Do you remember receiving any of the messages in particular? Why?"; and the open-ended question "Why?" was added after the question "Do you think you attended school more or less often while you received the messages?"

7.2 - Study One: An evaluation of an SMS-based autonomy supporting feedback intervention on school attendance rates - Method

To test participants understanding of the graphical attendance meter, the following questions were included:

If you received this message on a Wednesday what would it mean?

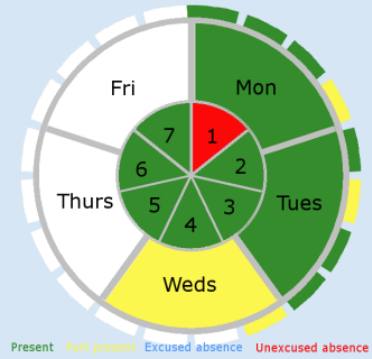
A. You had perfect attendance for the whole week

B. You missed first period today but perfect attendance otherwise

C. You missed the whole day today

D. You left early today

E. I don't know



If you received this message on a Friday what would it would mean?

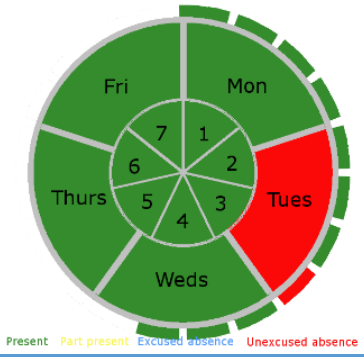
A. You had perfect attendance for the whole week

B. You missed some school today

C. You missed all day on Tuesday but perfect attendance otherwise

D. You left early today

E. I don't know



See Appendix 11.7 for a full copy of the Acceptability Questionnaire.

Topic	Example items from literature	References	Derived acceptability questionnaire items
Satisfaction with number of messages	Likert 1-5	(da Costa et al. 2012, Franklin et al. 2006, Castaño et al. 2012)	What did you think about how often you received messages? (Not often enough – Just right – Too often)
Satisfied with content	Likert 1-5 How would you rate the text message?	(Castaño et al. 2012, da Costa et al. 2012, Mbuagbaw et al. 2012)	How easy were the messages to understand? (Easy – neutral – Difficult) What did you think about the text in the messages? (Very interesting – Neutral – very boring)
Satisfied with length of message		(Castaño et al. 2012)	
Liked the timing of the messages		(da Costa et al. 2012)	Did you like the time that the messages were sent? (Very good time – neutral – very bad time)
Ignored the messages	I do not react to SMS reminders	(Boker et al. 2012, Vervloet et al. 2012)	How often did you read the messages (Always – sometimes – Never)
Would like to continue to receive	Likert 1-5	(da Costa et al. 2012, Franklin et al. 2006, Hou et al. 2010, Lester et al. 2010, Mbuagbaw et al.	Would you like to receive the messages for the rest of the year? (Yes – no preference – No)

	I would be willing to use a cell phone reminder system in the future to help me manage my diabetes Would like to continue to receive reminders? Do you want to continue receiving text messages?	2012, Pena-Robichaux et al. 2010, Dick et al. 2011, Dowshen et al. 2012)	
Believed it helped	Likert 1-5 Likert 1-5 I found the text message reminders to be helpful at decreasing the number of pills I missed I found the text message reminders to be helpful at increasing the number of times I check my feet I found the text message reminders to be helpful at decreasing the number of doctor visits that I missed How helpful were the messages this week (1-5) Helped to avoid missed doses?	(da Costa et al. 2012, Franklin et al. 2006, Granholm et al. 2012, Hardy et al. 2011, Mbuagbaw et al. 2012, Vervloet et al. 2012, Dick et al. 2011, Dowshen et al. 2012)	Do you think you attended school more or less often while you received the messages (More – neutral – Less)

	Helpful to remember refills? Helpful to remember medical appointments Did it [the message] help you remember to take your medication? SMS reminders support me in medication use SMS reminders are useful		
Found messages annoying	Not annoying – Very annoying SMS reminders are disturbing	(Boker et al. 2012, Ollivier et al. 2009, Vervloet et al. 2012)	How much trouble were the messages that you received? (Not annoying – neutral – Very annoying)
Easy to use	It was easy to receive and read the text messages from the research team It was easy to send text messages to the research team	(Dick et al. 2011)	
Would recommend to others	I would recommend a cell phone reminder system to my friends/family who have diabetes	(Lester et al. 2010, Mbuagbaw et al. 2012, Pena-Robichaux et al. 2010, Dick et al. 2011)	Would you recommend the messages to someone else starting at this school (Yes – no preference – No)

	Would you recommend it [text messages] to a friend?		Would you recommend the messages to someone at the high school? (Yes – no preference – No)
Privacy	Messages respected privacy?	(Dowshen et al. 2012)	
Wish it existed before	Reminders would have been helpful when starting medication	(Dowshen et al. 2012)	
Received	Received all messages?	(Dowshen et al. 2012)	
Enjoyed the messages		(Hardy et al. 2011)	Did you enjoy receiving the messages? (Enjoyed them – Didn't care – Did not like them)
Found messages useful	It was useless / I would never remember without it (1-10) Very Useful – Not useful	(Hou et al. 2010, Ollivier et al. 2009, Pena-Robichaux et al. 2010, Suffoletto et al. 2012a)	How useful were the messages that you received? (Useful – neutral – Not useful)
Would pay to use the service		(Hou et al. 2010)	
Experienced any problems?		(Pena-Robichaux et al. 2010)	

Table 14: Derivation of acceptability questionnaire items from the literature

7.2.2.2.6 Translation

The validated English measures were used for all students.

7.2.2.2.7 Procedures for measures

Students either completed the questionnaires with the help of the researcher in class or during lunch, or for those recruited during the school enrolment process, with the help of school administrators during the enrolment process. Once they completed the questionnaire, they were given a phone charger.

One week before the end of the school year, all students were asked to complete the second, identical set of measures, identical to those completed before the intervention and given a $10 gift card in return for their participation. Participants in the treatment groups were also asked to complete an acceptability of intervention questionnaire. Because many students graduated before the last week of school, some of the students were asked to complete the questionnaires when they returned for their graduation ceremony.

7.2.2.3 Demographics

Participant characteristics were measured in the same way as in the pilot study, see paragraph 6.2.3.

7.2.3 Intervention procedure

Once participants had consented to take part, had completed the initial measures and were added to the application database, their attendance from the start of the semester (January 2016) was imported into the database. Where students had not been enrolled at the start of the semester, their attendance since first enrolment was imported.

7.2.3.1 Setting

Messages were sent at the end of the school day so the students received them at home, on the way home or at their work. Because the messages were delivered by SMS they were stored in the

students' phones in a conversation thread which enabled students to review historic messages if they chose. Detailed descriptions of the messages sent to participants can be found in sections 6.5.1 and 6.5.3.

7.2.3.2 Intended exposure and time span

The intervention began on April 13 2016, lasted for 6 weeks and ended two weeks before the end of the school year to allow time for completing the final measures questionnaires.

7.2.3.3 Translation of message content

Participants were given a choice during recruitment to receive messages in English or Spanish. All messages sent during the intervention were sent in the language of their choice. Translation of message text was done by Google Translate.

7.2.4 Statistical analysis

Statistical analysis was undertaken using R version 3.3.2 for Windows 64 bit (R Core Team 2017).

Data was exported from the application as customised comma delimited files and manipulated in R to form a data table for analysis that consisted of two observations for each student, one before the intervention and another while messages were delivered. Each observation included measures of how many days they were enrolled in school, how many days they were present for at least part of the day, how many days they were present for all enrolled classes, and a mean percentage of enrolled periods that they were present for each day. Data from questionnaires and demographics were merged with this attendance data for analysis of secondary measures.

7.2.4.1 Main effect

Summary statistics for each measure were generated by calculating the mean and standard deviation for each measure aggregating by group and pre or post intervention period. One way ANOVA was used to check for significant differences between the groups' attendance rates before the intervention began.

Two-way ANOVA was used to check for significant differences between the groups and the pre/post intervention intervals. Because all hypotheses were predicting an increase in attendance rate, a one tailed test was used. Where a significant difference was found, Tukey's multiple comparison of means was used to identify the groups with significant differences. Graphs were plotted with error bars for visualisation.

While ANOVA p values confirm whether or not there is a significant difference between groups, they do not describe the strength of the difference, for this effect sizes are very helpful (Coe 2002, Sullivan and Feinn 2012). Cohen's d is a measure of the difference between means in terms of the number of standard deviations separating them and was calculated for differences between all groups.

7.2.4.2 Mediation analysis

A mediation analysis aims to identify factors that form part of the causal mechanism of an intervention effect. As such they are identified by showing that they account for part of the correlation of the independent variable. Baron et al (1986) describe the following procedure for the identification of a mediating variable:

1. Regress the mediator against the independent variable
2. Regress the dependent variable against the independent variable
3. Regress the dependent variable against the mediator and the independent variable

If the mediator variable is indeed mediating the effect then a significant correlation will be found in each equation and the effect of each is in the expected direction, then the variable may be considered to mediate the interaction. The final test is whether the effect of the independent variable is lower when combined with the mediator in the third equation than when analysed alone in the second. In other words, if the mediator variable accounts for some of the effect of the independent variable then it is a mediator. In the case of perfect mediation, the effect of the independent variable in the third equation would be zero, with the mediation variable accounting for all of the effect.

7.2.4.3 Moderation analysis

Because both text messaging interventions and attendance interventions have been found to have varying effects on sub-populations with different characteristics (Reid and Bailey-Dempsey 1995, Filion et al. 2015, Guillory et al. 2015), a moderation analysis was undertaken. Interactions of moderating variables with the group variables were investigated in two way ANOVA analyses of the post intervention data. Where a significant interaction was found between the group and moderating variable, a linear model was constructed relating the attendance measure to the group, moderating variable and the combination of group and moderator and coefficients for the moderation obtained.

7.2.4.4 Qualitative analysis

Two open response questions were included in the acceptability questionnaire to enable participants to share their impressions of the messaging treatments. While most of the items on the questionnaire were scored on a Likert scale and were very specific, these free response questions were phrased as openly as possible in order to capture participants' views that may not have been captured by the other items.

The free response items were analysed using a conventional content analysis approach (Hsieh and Shannon 2005). All responses were first read all together, in no particular order without participants' groups being labelled for immersion in the comments that participants made. They were then read one by one, again without labels, and the researcher coded each with categories that appeared from the comments. Once all responses were coded, the classes were combined where appropriate and grouped into themes. Group labels were then revealed and representation of each group in the themes was examined.

7.3 Results

7.3.1 Participant flow

Some materials have been removed due to 3rd party copyright. The unabridged version can be viewed in Lancester Library - Coventry University.

Figure 12: Study One – CONSORT 2010 Flow of participants
(Moher et al. 2010)

7.3.1.1 Treatment fidelity

When students' phones were on a cell phone network that did not accept MMS media, the message was automatically changed to send the message text together with a link to download the image by the Twilio service. 4 students in group FB and 10 students in group GRPH+AUTMY received these

adjusted messages. Three way ANOVA (all day absence as a function of group, time and message format) found no significant interaction of this alternative message format with attendance, $F(1,133)=1.96$, $p=0.2$.

Callback functions from the network confirmed whether messages had been sent, delivered or failed. Each time messages were sent, the researcher checked the callbacks and where messages had not sent successfully, they were resent.

One participant reported at the end of the trial that they had not received any messages and it was discovered that they had given an incorrect cell phone number at the start. The participant was excluded from all data analysis.

7.3.1.2 Participant withdrawals

No participants asked to withdraw from the trial and none sent STOP messages that would have automatically stopped any further messages being sent to them.

Due to the flexible nature of the campus and that it was the end of the school year, students did withdraw from enrolment at the school before the end of the trial (n=30, 39%). This was due to graduation (n=22), completing all of their classes for the year before the end of school (n=4), moving to another school (n=2) or other reasons (n=2).

The setting of the research made these early withdrawals from school during the trial period very likely and they had been anticipated in the research design. Measures of attendance were not affected by these withdrawals because they were calculated as days of absence as a proportion of days enrolled.

Where participants left school before the end of the trial, they were still asked to complete the repeated measures and, if appropriate, the intervention acceptability measure. It was not possible to intercept all students as the completed school for year and 25 participants (33%) did not complete the final questionnaire measures.

7.3.1.3 Exposure to intervention

As anticipated, students joined and left the study throughout the trial period. The hypothesis that any difference between groups in attendance after the intervention was due to different levels of exposure to the intervention was tested with ANOVA and rejected, $F(2,73)=1.625$, $p=0.204$. See Table 15.

	GRPH+AUTMY	GRAPHICAL	CONTROL	ANOVA
N	27	25	24	
Days of enrolment during trial period Mean (sd)	27.19 (8.705)	27.80 (8.337)	23.33 (11.07)	$F(2,73)=1.63$, $p=.2$

Table 15: Study One – Days enrolled in study by group

7.3.1.4 Participation in prior trials

Nine participants also participated in a pilot trial of the application between 19 October 2015 and 17 December 2015 described in chapter 4.3. The pilot trial did not include any questionnaire measures and the treatment groups received either simple messages stressing the importance and value of regular school attendance or messages of praise or support tailored to their recent attendance. There were no graphical messages and the text messages were delivered on a variable schedule.

It was assumed that this intervention was sufficiently different and temporally remote to allow participants to be enrolled in this study. This assumption was confirmed when attendance outcomes were analysed, both including and excluding these participants, to examine whether prior exposure affected their response to this trial. The results of analysis excluding these pilot participants demonstrated similar trends in the data but with lower significance, most likely due to the smaller sample size. See section 11.9 in Appendices for full analysis.

7.3.1.5 Missing data

Attendance data was automatically collected from the school attendance database and therefore there was no missing attendance data. Two participants (1 CONTROL, 1 GRAPHICAL) did not complete the pre-intervention questionnaire measures of mood, self-esteem, perceived autonomy at school and

stage of change. As described above, 25 out 76 participants did not complete post intervention questionnaire measures and acceptability questionnaires see section 7.3.1.2.

7.3.2 Baseline data

Baseline data was analysed and found that there were no significant differences between groups before the intervention began in terms of demographics, attendance rates, mood, self-esteem, perceived autonomy, stage of change or preferred language (see below).

7.3.2.1 Baseline - Demographics

ANOVA analyses were made of age, years since identification at risk, years since entering ninth grade and the number of days of pre-intervention attendance records available. No significant differences were found between groups in any of these measures. Fisher's Test found that there were no significant differences between groups in terms of categorical variables (gender, Federally identified race, Hispanic origin, current grade level, socioeconomic status, receipt of special education services, identification as at risk, riding the school bus, home language or primary language). See Table 16

	All	GRPH+AUTMY	GRAPHICAL	Control	Fisher's Test p / ANOVA
N	76 (100%)	27 (100%)	25 (100%)	24 (100%)	
Sex					
Male	44 (58%)	16 (59%)	12 (48%)	16 (67%)	0.4
Female	32 (42%)	11 (41%)	13 (52%)	8 (33%)	
Age (years)	17.7 (0.93)	17.6 (0.90)	17.9 (1.13)	17.6 (0.736)	F(2,73)=0.653, p=0.5
< 18:	47 (62%)	20 (74%)	11 (44%)	16 (67%)	0.09
>= 18:	29 (38%)	7 (26%)	14 (56%)	8 (33%)	
Federally identified race					
American Indian or Alaskan Native	15 (20%)	4 (15%)	7 (28%)	4 (17%)	
American Indian or Alaskan Native/White	2 (3%)	1 (4%)	1 (4%)	0 (0%)	0.6
Black or African American	11 (14%)	5 (19%)	4 (16%)	2 (8%)	
White	48 (63%)	17 (63%)	13 (52%)	18 (75%)	
Hispanic/Latino					
Yes	62 (82%)	19 (70%)	22 (88%)	21 (88%)	0.2
No	14 (18%)	8 (30%)	3 (12%)	3 (13%)	
Grade					
9th	18 (24%)	9 (33%)	5 (20%)	4 (17%)	
10th	10 (13%)	4 (15%)	1 (4%)	5 (21%)	0.5
11th	11 (14%)	3 (11%)	5 (20%)	3 (13%)	
12th	37 (49%)	11 (41%)	14 (56%)	12 (50%)	
Low socioeconomic status					
No	3 (4%)	1 (4%)	1 (4%)	1 (4%)	1
Yes	73 (96%)	26 (96%)	24 (96%)	23 (96%)	
Free lunch	65 (86%)	23 (85%)	23 (92%)	19 (79%)	0.7
Reduced price lunch	8 (11%)	3 (11%)	1 (4%)	4 (17%)	
Receiving special education services					
Yes	4 (5%)	2 (7%)	1 (4%)	1 (4%)	1
No	72 (95%)	25 (93%)	24 (96%)	23 (96%)	
At risk					
Yes	75 (99%)	27 (100%)	25 (100%)	23 (96%)	1
No	1 (1%)	0 (0%)	0 (0%)	1 (4%)	
Years since identification as at risk	2.36 (1.83)	2.27 (1.85)	2.58 (1.84)	2.31 (1.83)	F(2,72)=0.213, p=0.8
Years since entering 9th grade	2.49 (1.00)	2.41 (1.11)	2.63 (1.03)	2.44 (0.846)	F(2,73)=0.362, p=0.7
Distance from school (miles)	4.65 (17.7)	8.19 (4.81)	7.11 (4.95)	8.05 (4.25)	
Riding the bus					
Yes	18 (24%)	6 (22%)	6 (24%)	6 (25%)	1
No	58 (76%)	21 (78%)	19 (76%)	18 (75%)	
Home language					
English	32 (42%)	12 (44%)	11 (44%)	9 (38%)	
Spanish	43 (57%)	15 (56%)	13 (52%)	15 (63%)	0.8
Other	1 (1%)	0 (0%)	1 (4%)	0 (0%)	
Primary language					
English	35 (46%)	12 (44%)	12 (48%)	11 (46%)	
Spanish	40 (53%)	15 (56%)	12 (48%)	13 (54%)	0.9
Other	1 (1%)	0 (0%)	1 (4%)	0 (0%)	
Students with attendance records available before start of intervention	67	25	21	21	
Days of attendance records between start of semester and start of intervention	53.63 (17.34)	56.72 (15.13)	53.81 (20.85)	49.76 (15.98)	F(2,64)=0.918, p=0.4

Table 16: Study One – Baseline Participant characteristics and analyses comparing baseline characteristics by intervention group

7.3.2.2 Baseline - Attendance

Where attendance data was available for the period between 5 January 2016 and the start of the intervention on 13 April 2016, attendance rates were compared and ANOVA analysis found that there was no significant difference between the groups for days absent all day (unexcused), $F(2,64) = 0.11$, $p=0.9$ or for days with no unexcused absences. $F(2,64) = 0.53$, $p=0.6$. See Table 17.

	N	% days absent all day (unexcused) Mean % (sd)	% days with no unexcused absences Mean % (sd)	% classes missed with unexcused absences Mean % (sd)
Graphical Feedback + autonomy support (GRPH+AUTMY)	25	6.483 (6.972)	82.81 (14.33)	9.68 (8.83)
Graphical Feedback only (GRAPHICAL)	21	6.427 (6.574)	81.76 (13.80)	10.50 (9.14)
CONTROL	21	7.482 (10.96)	77.83 (21.92)	11.85 (12.72)
ANOVA		$F(2,64) = 0.110$, $p=0.9$	$F(2,64) = 0.532$, $p=0.6$	$F(2,64) = 0.254$, $p=0.8$

Table 17: Study One – Comparison of attendance rates before intervention (where data was available)

7.3.2.3 Baseline – Secondary measures

ANOVA analyses were made of the scores on the mood, single item self-esteem, perceived autonomy at school and truancy ladder measures and no significant differences were found between the groups. See Table 45 in Appendix 11.10.

7.3.2.4 Preferred language

Most participants chose English as the language of delivery for their messages (86%). The Fisher test showed no significant difference between the language choices of the groups. See Table 18.

	All participants	Control	GRAPHICAL	GRPH+AUTMY	Fisher Test
English	65 (86%)	21 (88%)	19 (76%)	25 (93%)	.3
Spanish	11 (14%)	3 (13%)	6 (24%)	2 (7.0%)	

Table 18: Study One – Choice of language for message delivery by group

7.3.3 Hypothesis 1

Sending feedback on recent attendance to students by SMS will increase attendance rates when compared to a no message control group.

Analyses of attendance of groups receiving messages are provided below.

7.3.3.1 Whole days missed

There was a significant difference between groups' absence rate when measuring the proportion of whole days missed with unexcused absences groups $F(1,139)=6.2$, $p=0.01$ but not over time $F(1,139)=3.7$, $p=0.06$ or the interaction of group and time interaction $F(1,139)=3.4$, $p=0.07$. (Table 19, Figure 13).

A significantly higher proportion of whole days were missed in the Control group n=24, M=16.36%, sd=19.92) than the group receiving messages (N=52, M=7.735%, sd=9.285).

Before sending the messages ANOVA showed that there had been no significant difference in absence rate between the groups, $F(2,64)=0.11$, $p=0.9$).

Cohen's d effect size was small: -0.44 (95% CI: (-0.74 — -0.14) and the 95% confidence interval did not include zero.

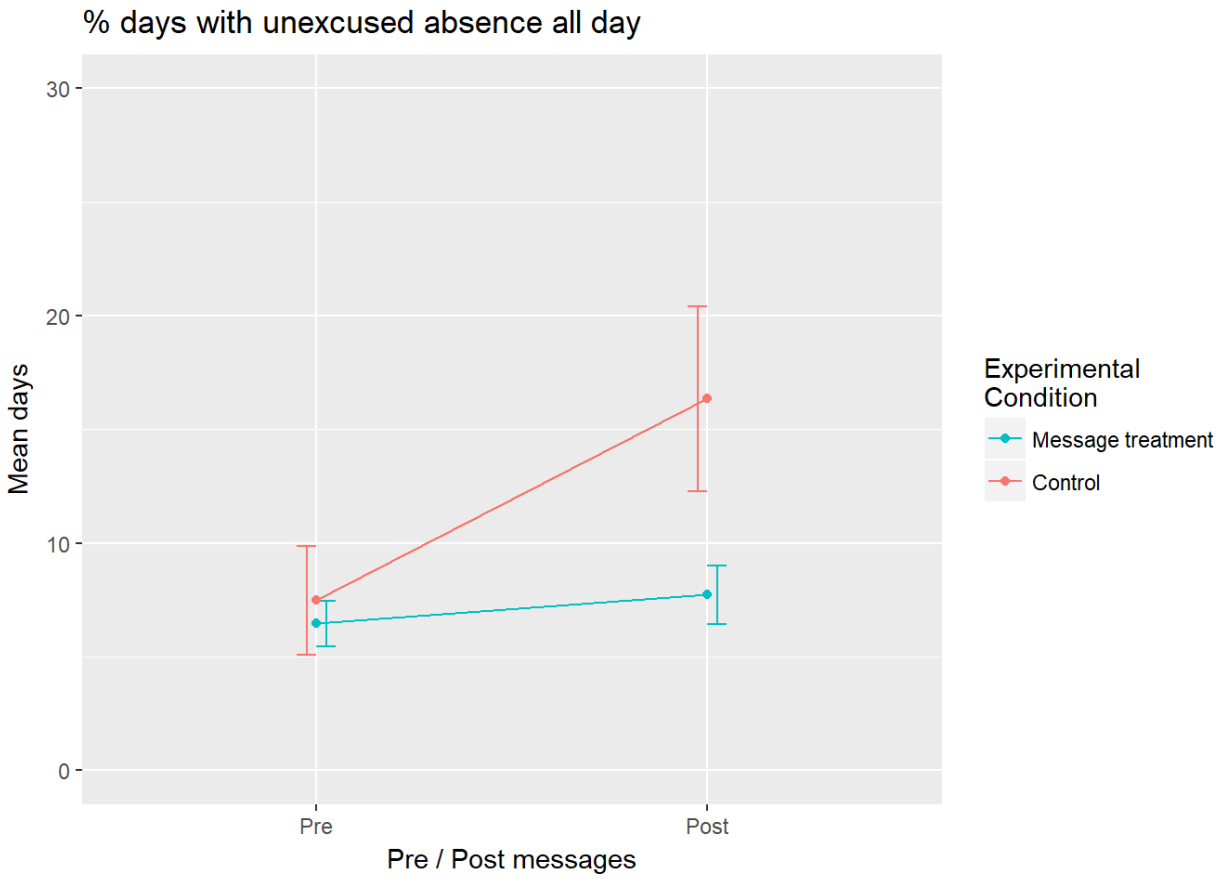


Figure 13: Study One – Mean absence rate (absent all day) comparing all students receiving messages (GRPH+AUTMY and GRAPHICAL) with CONTROL

7.3.3.2 Days with no absences

There was a significant difference between groups attendance rates when measuring the proportion of days missed with no unexcused absences $F(1,139)=5.08$, $p=0.03$ but not over time $F(1,139)=0.94$, $p=0.3$ or the interaction of group and time $F(1,139)=0.62$, $p=0.4$. (Table 19, Figure 14)

Participants in the treatment groups were present with no unexcused absences significantly more often (N=52, M=81.04%, sd=15.58) than the Control group (n=24, M=71.48%, sd=23.39).

Before sending the messages ANOVA showed that there had been no significant difference in attendance rate between the groups ($F(1,65)=1.0$, $p=.0.3$). Cohen's d effect size was small: 0.41 (95% CI: (0.11 – 0.71) and the 95% confidence interval did not include zero.

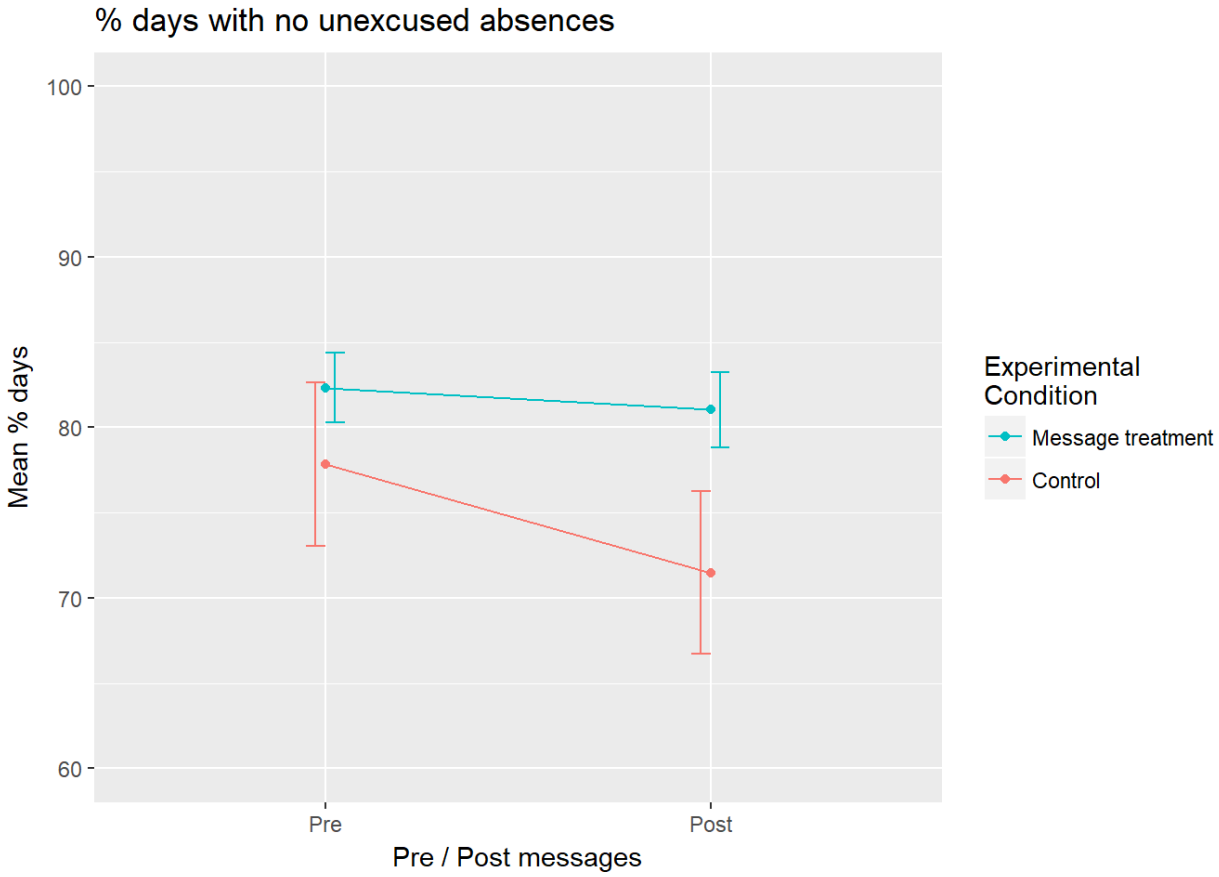


Figure 14: Study One – Mean full day attendance rate (no unexcused absences) comparing all students receiving messages (GRPH+AUTMY and GRAPHICAL) with CONTROL

7.3.3.3 Classes missed: percentage of scheduled classes missed with unexcused absences

There was a significant difference in absence rate between groups when measuring the proportion of scheduled classes missed with an unexcused absence, $F(1,139)=4.46$, $p=0.04$ but not over time $F(1,139)=2.8$, $p=0.1$ or the interaction of group and time $F(1,139)=1.55$, $p=0.2$.

Participants in the treatment group missed a significantly smaller proportion of their classes (N=52, M=11.80%, sd=11.48) than the Control group (N=24, M=19.33, sd=19.92). Cohen's d effect size was small: -0.38 (95% CI: -0.68 – 0.07).

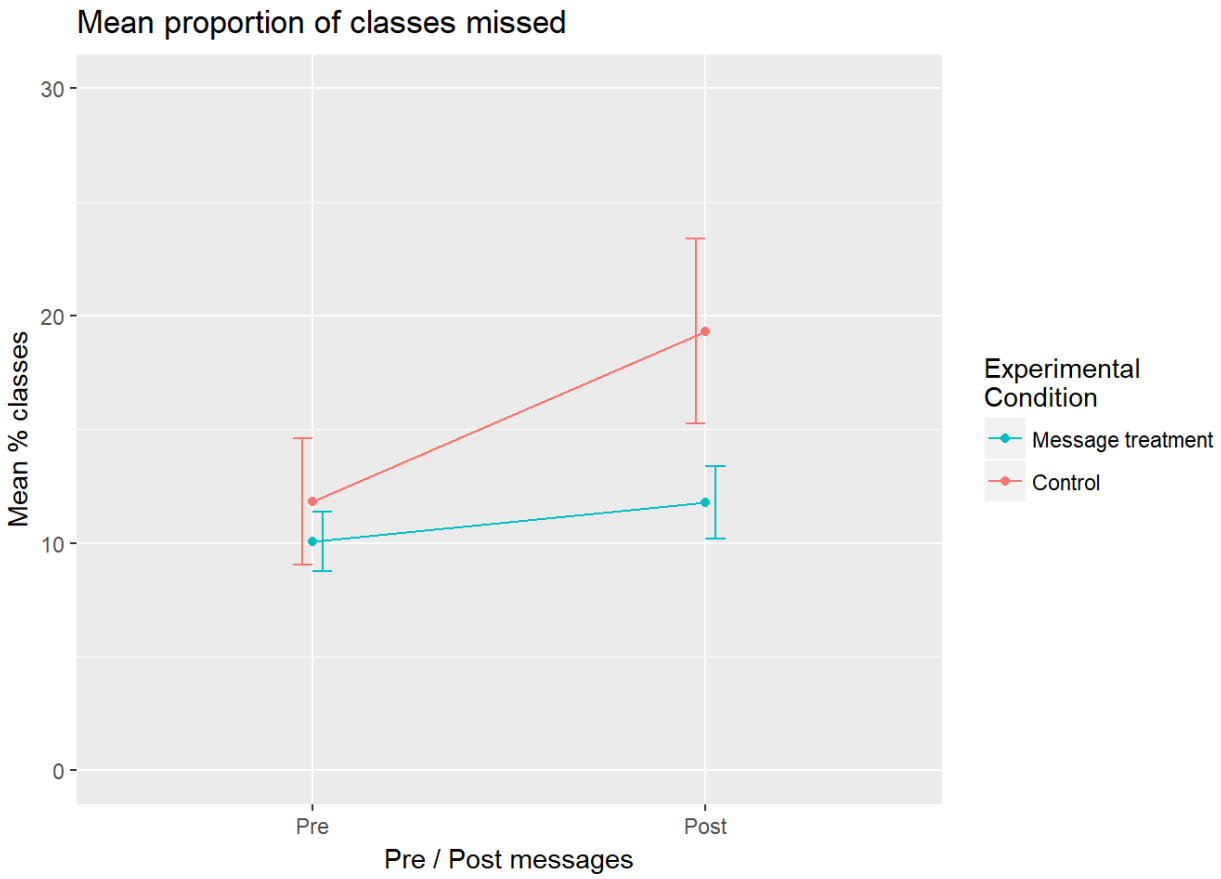


Figure 15: Study One –Mean class absence rate (classes absent in day / classes enrolled in day) comparing all students receiving messages (GRPH+AUTMY and GRAPHICAL) with CONTROL

7.3.3.4 Summary of findings

There was a significant difference between groups receiving feedback messages and those in the no message control group with absence rates being lower among participants receiving feedback messages with effect sizes averaging 0.41, This supports the hypothesis that feedback messages increase attendance.

7.3 - Study One: An evaluation of an SMS-based autonomy supporting feedback intervention on school attendance rates - Results

	Treatment		**Control**		**ANOVA**		
	Pre (N=46) Mean (sd)	**Post (N=52) Mean (sd)**	**Pre (N=21) Mean (sd)**	**Post (N=24) Mean (sd)**	**F(1,139) Group**	**F(1,139) PrePost**	Effect size (Cohen's d) (95% CI)
% days no unexcused absences	82.33 (13.94)	81.04 (15.58)	77.83 (21.92)	71.48 (23.39)	**5.08 ***	0.9359	**0.41 (0.11 – 0.71)**
% days unexcused all day	6.457 (6.718)	7.735 (9.285)	7.482 (10.96)	16.36 (19.92)	**6.158 ***	3.705	**-0.44 (-0.74 – -0.14)**
% of enrolled classes missed with unexcused absence	10.06 (8.88)	11.80 (11.49)	11.85 (12.72)	19.92 (19.33)	**4.46 ***	2.755	**-0.38 (-0.68 – -0.077)**

*** p<.05**

Table 19: Study One – Mean attendance rates comparing all students receiving messages (GRPH+AUTMY and GRAPHICAL) with CONTROL

7.3.4 Hypothesis 2

Sending graphical feedback together with autonomy supporting messages will increase attendance rates when compared with sending only graphical feedback and with a no message control group.

Analyses of attendance of groups receiving each type of message are provided below.

7.3.4.1 All day absences: Percentage of days when absent all day (unexcused)

The average percentage of days when students were absent all day was higher in the control group (n= 24, M=16.36%, sd= 19.92) than either of the treatment groups (GRPH+AUTMY: n=27, M= 7.105%, sd=9.513 and GRAPHICAL: n=25, M=8.415%, sd=9.178) after exposure to the messages. See Figure 16. A two-way ANOVA analysis found the difference between the groups' absence rate to be significant, $F(2,137) = 3.1$, p=0.05. Post hoc Tukey HSD analysis found the difference between GRPH+AUTMY (N=25, M=7.1%, sd=9.5) and CONTROL (n=24, M=16%, sd=20) to be only marginally significant (p=.056) while the differences between GRAPHICAL and CONTROL and between GRPH+AUTMY and GRAPHICAL were not significant (p=.1 and p=1.0 respectively).

Cohen's d effect sizes were medium and small: GRPH+AUTMY vs CONTROL -0.60 (95% CI: -1.2 – -0.03) and GRAPHICAL vs CONTROL -0.52 (95% CI: -1.1 – 0.07) with negligible effect sizes when comparing GRPH+AUTMY and GRAPHICAL). See Table 20.

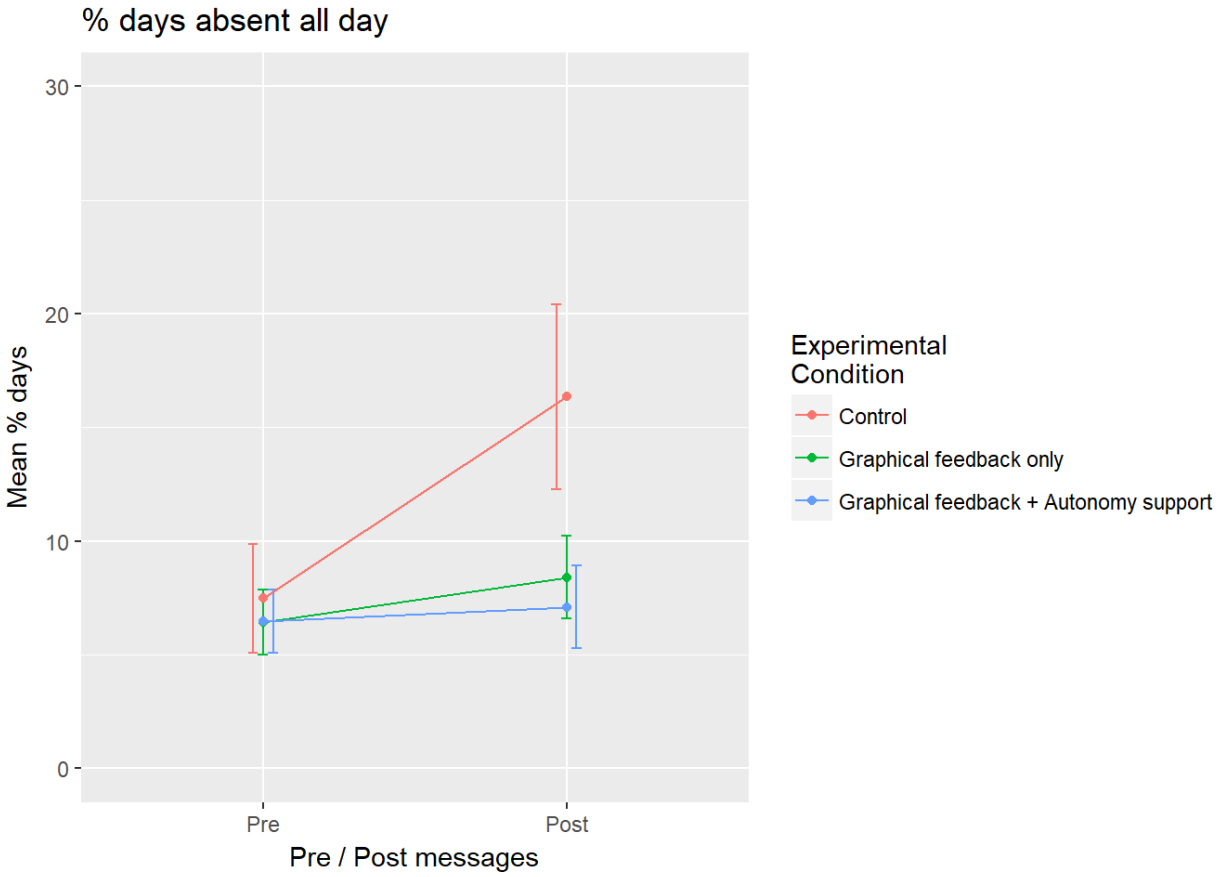


Figure 16: Study One Mean absence rate (absent all day) comparing students in groups GRAPHICAL, GRPH+AUTMY and CONTROL

7.3.4.2 No absences: Percentage of days with no unexcused absences

The proportion of days with no unexcused absences showed a similar pattern with lower average attendance rates in the control group (n=24, M=71.48%, sd=23.39) compared with the treatment groups (GRPH+AUTMY: n=27, M=80.03%, sd=15.14) and GRAPHICAL: n=25, M=82.14%, sd=16.86). See Figure 17. Two way ANOVA analysis did not show a significant difference between groups, $F(2,137) = 2.5$, p=0.08.

Cohen's d effect sizes were small and medium: GRPH+AUTMY vs CONTROL 0.44 (95% CI: -0.13 – 1.00) and GRAPHICAL vs CONTROL 0.52 (95% CI: -0.06 – 1.1) with negligible effect sizes when comparing GRPH+AUTMY and GRAPHICAL). See Table 20.

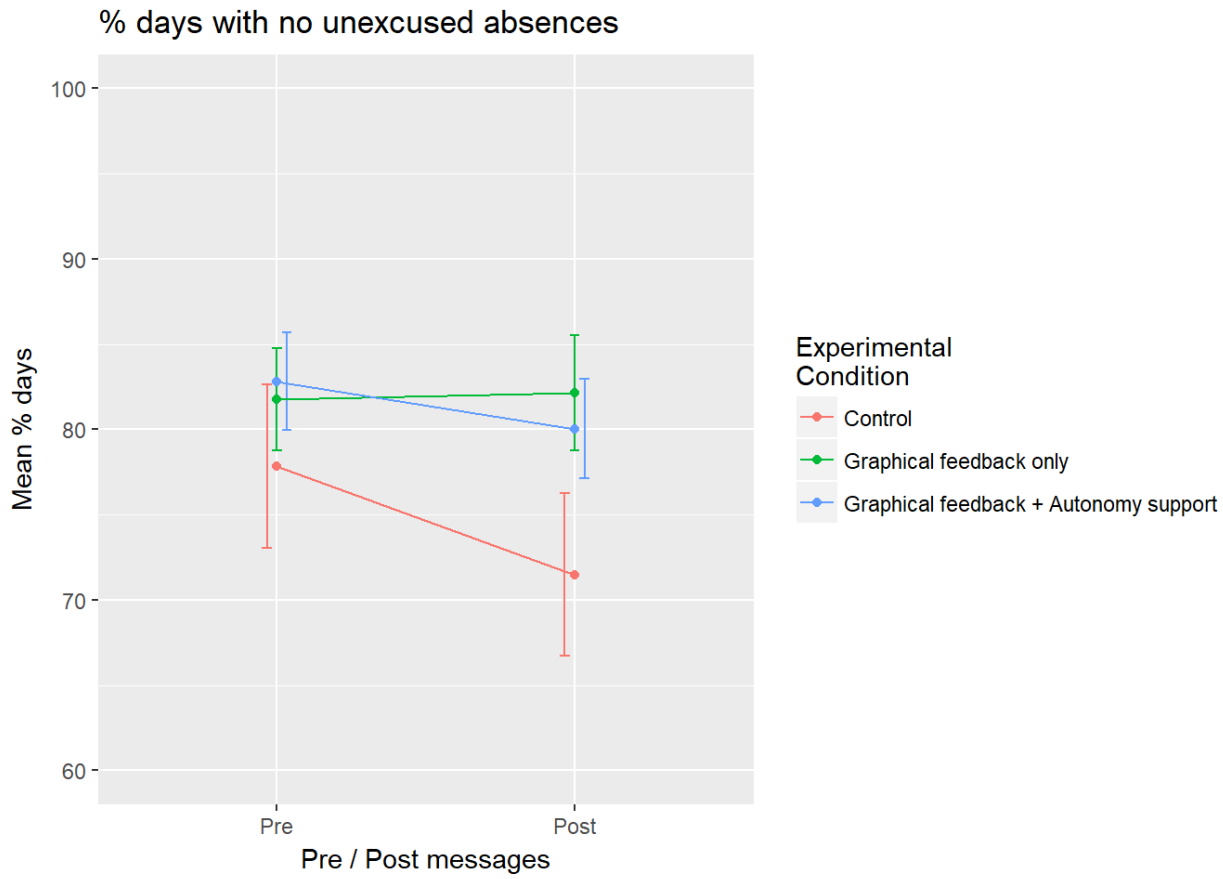


Figure 17: Study One – Proportion of days with no absences comparing students in groups GRAPHICAL, GRPH+AUTMY and CONTROL

7.3.4.3 Classes missed: percentage of scheduled classes missed with unexcused absences

When number of classes for which a student was scheduled was compared to the number of classes in which they were absent (unexcused) there is a similar pattern with higher absence rates in the control group (n=24, M=19.33%, sd=19.92) compared with the treatment groups (GRPH+AUTMY: n=27, M=11.72%, sd=11.54 and GRAPHICAL: n=25, M=11.89%, sd=11.65) (see Figure 18).

Two-way ANOVA analysis did not show a significant difference between the groups, $F(2,137)=2.218$, p=0.1. Cohen's d effect sizes were small: GRPH+AUTMY vs CONTROL -0.47 (95% CI: -1.0 – 0.10) and GRAPHICAL vs CONTROL -0.46 (95% CI: -1.0 – 0.12) with negligible effect sizes when comparing GRPH+AUTMY and GRAPHICAL). See Table 20.

		Treatment						ANOVA		Effect size (Cohen's d) (95% CI)
		GRPH+AUTMY		GRAPHICAL		Control				
		Pre (N=25) Mean (sd)	Post (N=27) Mean (sd)	Pre (N=21) Mean (sd)	Post (N=25) Mean (sd)	Pre (N=21) Mean (sd)	Post (N=24) Mean (sd)	F(2,137) Group	F(2,137) PrePost	
Experiment One	% days no unexcused absences	82.81 (14.33)	80.03 (15.14)	81.76 (13.8)	82.14 (16.86)	77.83 (21.92)	71.48 (22.39)	2.521	0.9307	AUTMY/CON 0.44 (-0.13 – 1.00) FB/CON 0.52 (-0.06 – 1.1) AUTO/FB -0.13 (-0.69 – 0.42)
	% days unexcused all day	6.483 (6.972)	7.105 (9.513)	6.427 (6.574)	8.415 (9.178)	7.482 (10.96)	16.36 (19.92)	**3.085 ***	3.635	**AUTMY/CON -0.60 (-1.2 — -0.028)** FB/CON -0.52 (-1.1 – 0.069) AUTOMY/FB -0.14 (-0.70 – 0.42)
	% classes missed with unexcused absence	9.681 (8.830)	11.72 (11.54)	10.50 (9.137)	11.89 (11.65)	11.85 (12.72)	19.33 (19.92)	2.213	2.705	AUTMY/CON -0.47 (-1.0 – 0.10) FB/CON -0.46 (-1.0 – 0.12) AUTMY/FB -0.015 (-0.57 – 0.54)

* p<.05

Table 20: Study One – Absences rates of all participants comparing students in groups GRAPHICAL, GRPH+AUTMY and CONTROL

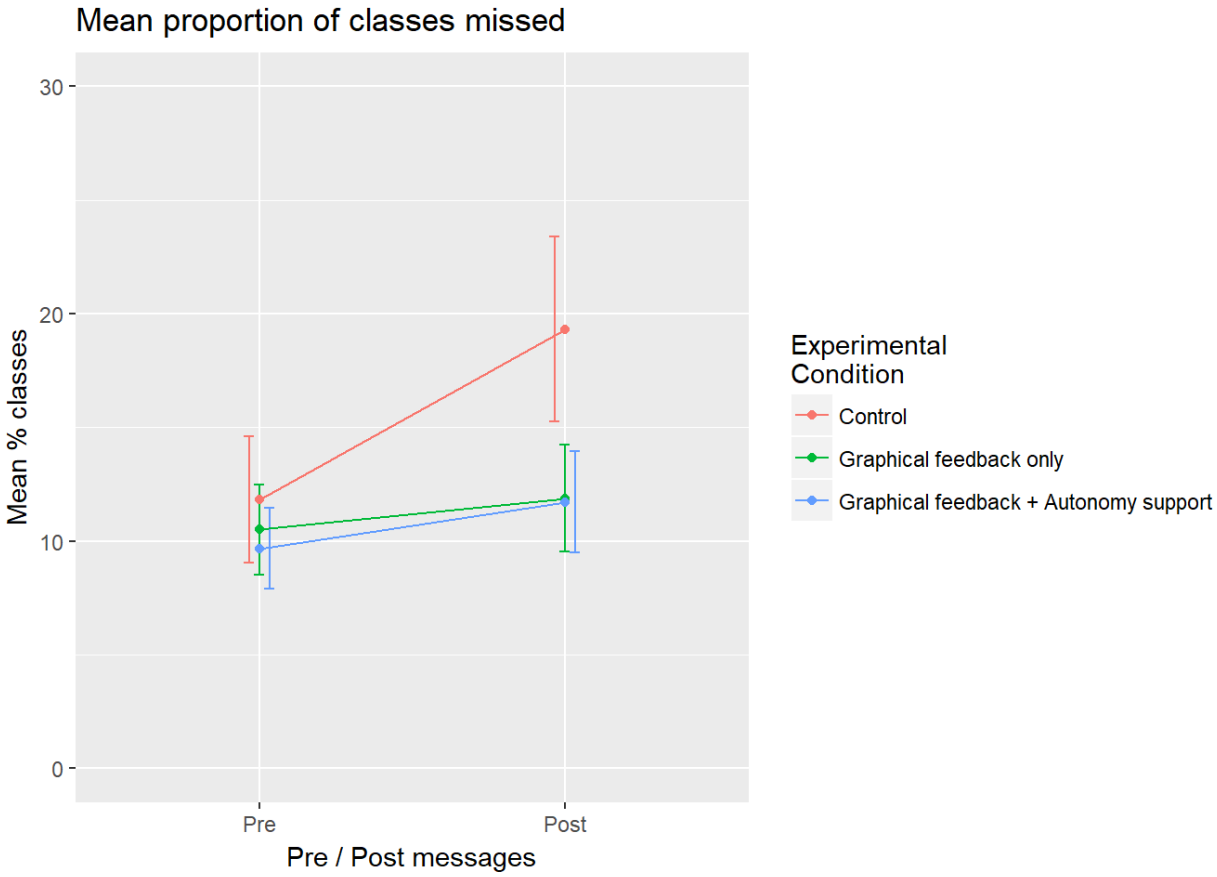


Figure 18: Study One – Percentage of classes missed (unexcused) comparing students in groups GRAPHICAL, GRPH+AUTMY and CONTROL

7.3.4.4 Summary of findings

There were no significant differences in absence rates between students receiving autonomy support messages together with graphical feedback on attendance and those receiving only graphical feedback. Both experimental groups demonstrated similar differences when compared to the control group. The results did not support the hypothesis.

7.3.5 Hypothesis 3

Sending autonomy supporting messages will increase perceived autonomy of recipients when compared to participants receiving messages without autonomy supporting components and with a no message control group.

There were no significant differences in perceived autonomy between the participants receiving autonomy supporting messages and those receiving only feedback. The results do not support the hypothesis. See Table 45 in appendices.

7.3.5.1 Autonomy, self-esteem, mood and stage of change measures

Questionnaires consisting for self-esteem, stage of change ("truancy ladder"[6]), perceived autonomy and mood were completed by participants before and after the messages were delivered. All students completed the pre-intervention questionnaires. 66% of participants completed the post intervention questionnaires, others did not because they left school (either because they graduated or for other reasons) and were not available to complete it.

While administering the secondary measures, the researcher found some participants struggled to complete the measures because their English was not sufficiently advanced (their first language was Spanish). Some participants (both English and Spanish speakers) did not understand the meaning of the phrase "I have high self-esteem" used in the single question self-esteem measure (Robins et al. 2001) and the researcher had to explain it to them.

Summary statistics were prepared for each group and before and after intervention and analysed with one-way ANOVA to detect differences between the groups. Means and standard deviations were based on available data for each measure.

No significant differences were found between groups in any of the measures. See Table 45.

[6] The Truancy Ladder is a custom instrument. See section 7.2.2.2.4 for details of its construction.

7.3.6 Acceptability measure

33 participants completed the acceptability questionnaire 14 from the feedback only group (GRAPHICAL) and 19 from the feedback plus autonomy supporting text group (GRPH+AUTMY).

7.3.6.1 Quantitative analysis

There was no significant difference between groups in any of the answers to the acceptability questionnaire (see Table 46). The distribution of answers can be seen in Figure 41, Figure 42, Figure 43 and Figure 44 in Appendix 11.11.

7.3.6.2 Qualitative content analysis of free response items

The free text answers listed in Table 21 and Table 22 were analysed using a conventional contents analysis approach as described in section 7.2.4.4.

Answer to "Why?" free text question following "Do you think you attended school more or less often while you received the messages?"	
Graphical Feedback only (GRAPHICAL)	**Graphical Feedback + autonomy support (GRPH+AUTMY)**
Tells me what days and periods I was at school	Helps me learn more
The messages give you a goal	Yes cause they got so annoying I started coming to school to stop receiving them
Made me realize where my fault was at (which days I missed - mainly Tuesdays and Wednesdays)	Cause I stated seeing how many days I actually missed
I attended school like normal. I tried to attend as much as possible	I've always come to school, the msg were just a reminder
Because I was always reminded	Because it shared me the attendance and if I missed a day I would try and not miss a class
It didn't really change. I always tried to come to school every day	It got me through the day - the quotes
I could track my absences	This way I could see how many days I was missing - before I didn't know
Just coming to school anyway	Because it lets me know I'm doing good
cause I don't like to missed school days	I don't know
because sometimes I couldn't controlate! [control it]	It was always good to receive something encouraging
Because so I can tell when I accidentally marked absent and I can fix it	

Table 21: Study One – Answer to "Why?" free text question following "Do you think you attended school more or less often while you received the messages?"

Answer to "Do you remember receiving any of the messages in particular? Why?"	
Graphical Feedback only (GRAPHICAL)	**Graphical Feedback + autonomy support (GRPH+AUTMY)**
Yes, all week except weekends	Yes, because I went every day that week
Just attendance because it was sending every day	Kinda - I remember a couple that made me feel good. Like it was very cool
The attendance	Yes because they texted me, my attendance and they also said not to give up
Yes, remind me days I missed	No but they did get so annoying that I started
8 x "No"	Yes all week except weekends"
	9 x "No"

Table 22: Study One – Answer to "Do you remember receiving any of the messages in particular? Why?"

7.3.6.2.1 Question: Do you think you attended school more or less often while you received the messages? Why?

Examination of all responses fell into themes of reminding/tracking, having no effect because they already attended regularly, empowerment, and encouragement.

Reminding/tracking

This was the most commonly occurring theme and covered many answers referring to the way the messages helped participants to keep track of their attendance. For example, "because it helped me keep track of how many times I had come late or missed school" or it "tells me what days and periods I was at school" or "'cause I started seeing how many days I actually missed". It is interesting to note that in many cases of students' relating the benefit of keeping track of their attendance, they appear to suggest that they would not otherwise have known. One participant made that point explicitly, "This way I could see how many days I was missing – before I didn't know". One student felt that the messages gave them a goal. These responses were evenly distributed across both treatment groups.

One response used the word "tell" ("Tells me what days and period I was in school"). Another suggested that it was their fault ("Made me realize where my fault was at (which days I missed – mainly

Tuesdays and Wednesdays)"). Both of these, possibly negative impressions were in the GRAPHICAL group. A student in the GRPH+AUTMY group said "[yes cause] they got so annoying I started coming to school to stop receiving them". This student later told the researcher that this was a positive comment and a joke.

No effect

Six students answered that the intervention had little effect because they would have come to school in any case. For example, "it didn't really change. I always tried to come to school every day". Five of the students were in the GRAPHICAL group.

Empowerment

Two students referred to empowerment, one to say that she was in control over whether she could come to school or not and another who answered that "because so I can tell when I accidently marked absent and I can fix it".

Encouragement

Three students from the GRPH+AUTMY group answered that the messages were motivating, supporting or encouraging. "It got me through the day – the quotes", "Because it let me know I'm doing good" and "It was always good to received something encouraging".

7.3.6.2.2 Question: Do you remember receiving any of the messages in particular? Why?

No

The most common theme was where participants answered "No". Some answers may have suggested that the messages were repetitive, but this is very speculative: "just attendance because it was sending every day" or "yes, all week except weekends".

Specific memories

Two students from the GRAPHICAL group answered that they remembered negative feedback, the days that they had missed and one added that it was helpful. Another student, in the GRPH+AUTMY

group, remembered a positive moment, a week when they had good attendance: "Yes, because I went every day that week". The same student as in the previous question answered that the messages were so annoying that they started going to school again.

Motivation and encouragement

Two students from the GRPH+AUTMY group remembered motivational aspects of the messages: "Yes because they texted me my attendance and they also said not to give up" and "Kinda – I remember a couple that made me feel good. Like it was very cool."

7.3.7 Moderation analysis

Three way ANOVA of all day absences against group, time and moderating variables (see Table 23) found significant interactions of group and Hispanic/Latino classification (p=0.02) and home language (p=0.01). There was also a significant interaction between group, home language and time (p=0.04).

Possible moderators were screened by constructing a linear model relating attendance variables to group, possible moderator and the interaction of the two.

In the model based on Hispanic/Latino classification, a significant regression equation was found ($F(11,131)=2.2$, p=0.02) with $R^2 = 0.15$ but only the interaction of GRPH+AUTMY treatment and Hispanic/Latino classification was significant (p=0.02).

In the model based on Home Language a significant regression equation was found ($F(12,130)=2.6$, p=0.004) with an $R^2 = 0.19$. Home Language being Spanish significantly increased absence (β=15.9, p=0.0009) and the interaction of Home Language with treatment groups reduced absences (GRAPHICAL: β=-21.9, p=0.001; GRPH+AUTMY: β=-21. 1, p=0.001). Pre-intervention attendance rates interacted with Home Language=Spanish (β=-17.0, p=0.01) and the interaction of Home Language=Spanish and FB treatment (β=24.0, p=0.01).

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Because Home Language appeared to show that having Spanish as their home language resulted in higher rates of absence (+15.9%) and that application of either treatment reduced absence by more than that amount (-21.5%) further analysis was undertaken of this sub-population and is described in Post Hoc Analysis, section 7.3.8.1.

		ANOVA Mean % days absent all day (unexcused)		
		Interaction of moderating variable with Group, Time and Group x Time		
		Group	**PrePost**	**Group * PrePost**
Moderating variable	Gender	F(2,131)=0.104,p=0.9	F(1,131)=1.71, p=0.2	F(2,131)=0.237, p=0.8
	Hispanic	**F(2,131)=4.25, p=0.02**	F(1,131)=0.0435, p=0.8	F(2,131)=0.628, p=0.5
	At risk	n.a.	F(1,131)=0.0010, p=1.0	n.a.
	Special education	F(2,131)=0.213,P=0.8	F(1,131)=0.261, p=0.6	F(2,131,)=0.171, p=0.8
	Race	F(5,121)=1.60, p=0.2	F(3,121)=0.0819, p=1.0	F(5,121)=0.397, p=0.9
	Graduation year	F(6,119)=1.803, p=0.1	F(3,119)=0.580, p=0.6	F(6,119)=0.261, p=1.0
	Grade level	F(6,119)=1.803,p=0.1	F(3,119)=0.580, p=0.6	F(6,119)=0.261, p=1.0
	Primary language	F(2,130)=1.214, p=0.4	F(1,130)=1.111, p=0.3	**F(2,130)=3.515, p=0.03**
	Home language	**F(2,130)=4.415, p=0.01**	F(1,130)=0.6169,p=.43362	**F(2,130)=3.36, p=0.04**
	Low SES	F(2,131)=0.100, p=0.9)	F(1,131)=0.0102, p=0.9	F(2,131)=0.108, p=0.9
	Rides school bus	F(2,131)=0.818, p=0.4	F(1,131)=1.17, p=0.3	F(2,131)=0.078, p=0.9
	Age	F(2,131)=0.767, p=0.5	F(1,131)=0.0847, p=0.8	F(2,131)=0.283, p=0.8
	Years since identification as At Risk	F(2,129)=0.401, p=0.5	F(1,129)=0, p=1.0	F(2,129)=0.302, p=0.7
	Years since 9th grade	F(2,131)=0.943, p=0.4	F(1,131)=0.0978, p=0.8	F(2,131)=0.101, p=0.9

Table 23: Study One – Moderation analysis exploratory ANOVA

7.3.8 Post-hoc analyses

The following analyses were conducted as a result of observations made and not with a view to answering the original hypotheses. As such, any conclusions drawn from them should be considered to be more speculative than those that were initially planned.

7.3.8.1 Periods of absence

Examination of attendance during the intervention of participants in the two treatment groups who were not present for the full day but were present for at least one period found that in 57% of such occasions they were absent for only one period of the day. Examination of which periods participants were absent when only absent for one period in the day found that most (29%) were absent for the first period, followed by 18% who were absent for the class immediately after lunch and rates for all other classes were 14% or lower.

7.3.8.2 Changes to attendance records

The changes made to attendance data by school administrators was analysed by group after the intervention started. Data of changes to attendance before the intervention began were not available. Because some changes were for one class period and some changes for multiple periods, the changes were aggregated per student per day so that a count was made of change "events" rather than the number of periods changed. See Table 24. While some students remarked in the acceptability questionnaire that they used the messages to prompt them to correct attendance errors, this does not appear to have been widespread given that changes to participants in the CONTROL who received no messages were as common as in either intervention group.

	CONTROL	GRAPHICAL	GRPH+AUTMY
From absent to not absent	13	7	11
From unexcused to excused	19	19	21

Table 24: Study One – Comparison of change to attendance by group

7.3.8.3 Analysis by prior attendance rate

Filion et al (2015) found that a sleep improvement intervention worked best on those who started the intervention with poor sleep. Similarly, Cabus and DeWitt (2015) found that an intervention to support school attendance through home visits and family counselling was more effective among students with the lowest academic ability. In this analysis participants in each group were divided into quartiles based on their attendance rates prior to the intervention and each quartile's attendance compared using each of the attendance measures to examine whether a similar concentration of effect could be found in pre-intervention attendance behaviours. See Table 25.

Figure 19, Figure 20 and Figure 21 together with the data in Table 25 show the intervention had the greatest effect not on the students with the highest or lowest absence rates but those in the second quartile of absenteeism rate (Figure 19 and Figure 20) and third quartile of attendance rate (Figure 19), which are equivalent, with effect sizes as high as 2.1 (95% confidence interval 0.28 – 3.9). There was no significant difference in effect between GRAPHICAL and GRPH+AUTMY.

		Treatment % Mean (sd)						ANOVA			Effect Size
		GRPH+AUTMY		GRAPHICAL		CONTROL					
Quartile		Pre	Post	Pre	Post	Pre	Post	Group	PrePost	Group x PrePost	Cohen's d (95% confidence interval)
1	% days no unexcused absences	n=7		n=6		n=6					
		63.3 (7.7)	69.8 (17.7)	64.2 (7.8)	70.5 (24.1)	49.2 (19.9)	63.0 (18.8)	F(2,32) 1.66	F(1,32) 2.51	F(2,32) 0.19	AUTMY/CON 0.37 (-0.86 – 1.6) FB/CON 0.36 (-0.86 – 1.6) AUTOMY/FB -0.03 (-0.95 – 1.6)
	% days unexcused all day	n=7		n=6		n=6					
		0.00 (0.00)	4.52 (9.1)	0.78 (0.86)	3.70 (9.1)	0.00 (0.00)	12.9 (16.8)	F(2,32) 0.99	**F(1,32) 5.80 ****	F(2,32) 1.20	AUTMY/CON -0.63 (-1.9 – 0.6) FB/CON -0.68 (-2.0 – 0.6) AUTOMY/FB 0.09 (-2.0 – 0.64)
	% classes missed with unexcused absence	n=7		n=6		n=6					
		0.82 (1.0)	4.19 (4.2)	1.58 (1.6)	5.34 (10.9)	1.22 (0.63)	9.02 (10.3)	F(2,32) 0.594	**F(1.32) 5.84 ****	F(2,32) 0.480	AUTMY/CON -0.64 (-1.9 – 0.6) FB/CON -0.35 (-1.6 – 0.9) AUTOMY/FB -0.14 (-1.4 – 1.1)
2	% days no unexcused absences	n=6		n=5		n=5					
		82.6 (6.0)	80.5 (15.3)	79.6 (4.7)	85.5 (5.5)	80.7 (4.0)	65.8 (25.4)	F(2,26) 1.63	F(1,26) 0.62	F(2,26) 01.69	AUTMY/CON 0.72 (-0.70 – 2.1) FB/CON 1.1 (-0.49 – 2.6) AUTOMY/FB -0.42 (-1.8 – 1.0)
	% days unexcused all day	n=6		n=5		n=5					
		2.34 (0.86)	2.18 (3.7)	3.46 (1.3)	6.06 (7.1)	2.69 (1.2)	20.18 (17.9)	**F(2,26) 3.98 ****	**F(1,26) 5.14 ****	**F(2,26) 3.93 ****	**AUTMY/CON -1.5 (-3.0 – 0.07)** FB/CON -1.0 (-2.6 – 0.5) AUTOMY/FB -0.71 (-2.6 – 0.5)
	% classes missed with unexcused absence	n=6		n=5		n=5					
		4.41 (1.1)	6.31 (3.8)	5.65 (2.1)	7.41 (5.9)	6.94 (3.2)	27.41 (19.2)	**F(2,26) 6.59 *****	**F(1,26) 7.01 ****	**F(2,26) 4.45 ****	**AUTMY/CON -1.6 (-3.2 - -0.04)** FB/CON -1.4 (-3.0 – 0.2) AUTOMY/FB -0.23 (-1.6 – 1.1)
3	% days no unexcused absences	n=6		n=5		n=5					
		91.4 (1.6)	81.1 (14.8)	80.3 (2.0)	96.4 (3.3)	90.7 (3.8)	75.0 (14.1)	**F(2,26) 3.68 ****	**F(1,26) 4.86 ****	**F(2,26) 4.49 ****	AUTMY/CON 0.42 (-0.97 – 1.8) **FB/CON 2.1 (0.28 – 3.9)** AUTOMY/FB -1.36 (-2.9 – 0.2)
	% days unexcused all day	n=6		n=5		n=5					
		7.74 (4.2)	5.57 (6.3)	7.44 (1.6)	5.45 (5.8)	6.70 (1.0)	9.77 (7.9)	F(2,26) 0.37	F(1,26) 0.069	F(2,26) 0.87	AUTMY/CON -0.60 (-2.0 – 0.8) FB/CON -0.62 (-2.1 – 0.9) AUTOMY/FB 0.02 (-2.1 -0.9)
	% classes missed with unexcused absence	n=6		n=5		n=5					
		12.85 (5.3)	14.04 (7.8)	13.75 (2.4)	9.37 (5.1)	14.04 (7.8)	14.72 (6.9)	F(2,26) 0.381	F(1,26) 0.00	F(2,26) 36.64	AUTMY/CON -0.092 (-1.5 – 1.3) FB/CON -0.88 (-2.4 – 0.7) AUTOMY/FB 0.70 (-0.71 – 2.1)

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Quartile		Pre	Post	Pre	Post	Pre	Post	Group	PrePost	Group x PrePost	Cohen's d (95% confidence interval)
4	N	n=6		n=5		n=5					
	% days no unexcused absences	97.2 (2.5)	90.3 (8.6)	96.6 (3.4)	82.0 (16.6)	96.4 (0.6)	83.8 (16.8)	F(2,26) 0.61	**F(1,26) 9.5 *** **	F(2,26) 0.65	AUTMY/CON 0.51 (-0.89 – 1.90) FB/CON 0.51 (-1.6 – 1.4) AUTOMY/FB 0.65 (-1.6 – 1.4)
	% days unexcused all day	n=6		n=5		n=5					
		16.92 (1.8)	18.94 (9.4)	15.15 (7.5)	13.56 (6.3)	22.03 (14.8)	18.81 (23.6)	F(2,26) 0.612	F(1,26) 0.0295	F(2,26) 0.131	AUTMY/CON 0.0 (-1.4 – 1.4) FB/CON -0.30 (-1.8 – 1.2) AUTOMY/FB 0.66 (-1.8 – 1.2)
	% classes missed with unexcused absence	n=6		n=5		n=5					
		22.12 (1.6)	26.39 (13.7)	22.82 (7.2)	19.89 (13.6)	29.52 (14.3)	24.29 (20.1)	F(2,26) 0.462	F(1,26) 0.0437	F(2,26) 0.412	AUTMY/CON 0.12 (-1.2 – 1.5) FB/CON -0.26 (-1.7 – 1.2) AUTOMY/FB 0.48 (-0.9 – 1.9)

*** p < 0.1**
**** p < 0.05**
***** p < 0.01**
****** p < 0.001**

Table 25: Study One – Attendance rates by pre-intervention attendance quartiles comparing students in groups GRAPHICAL, GRPH+AUTMY and CONTROL

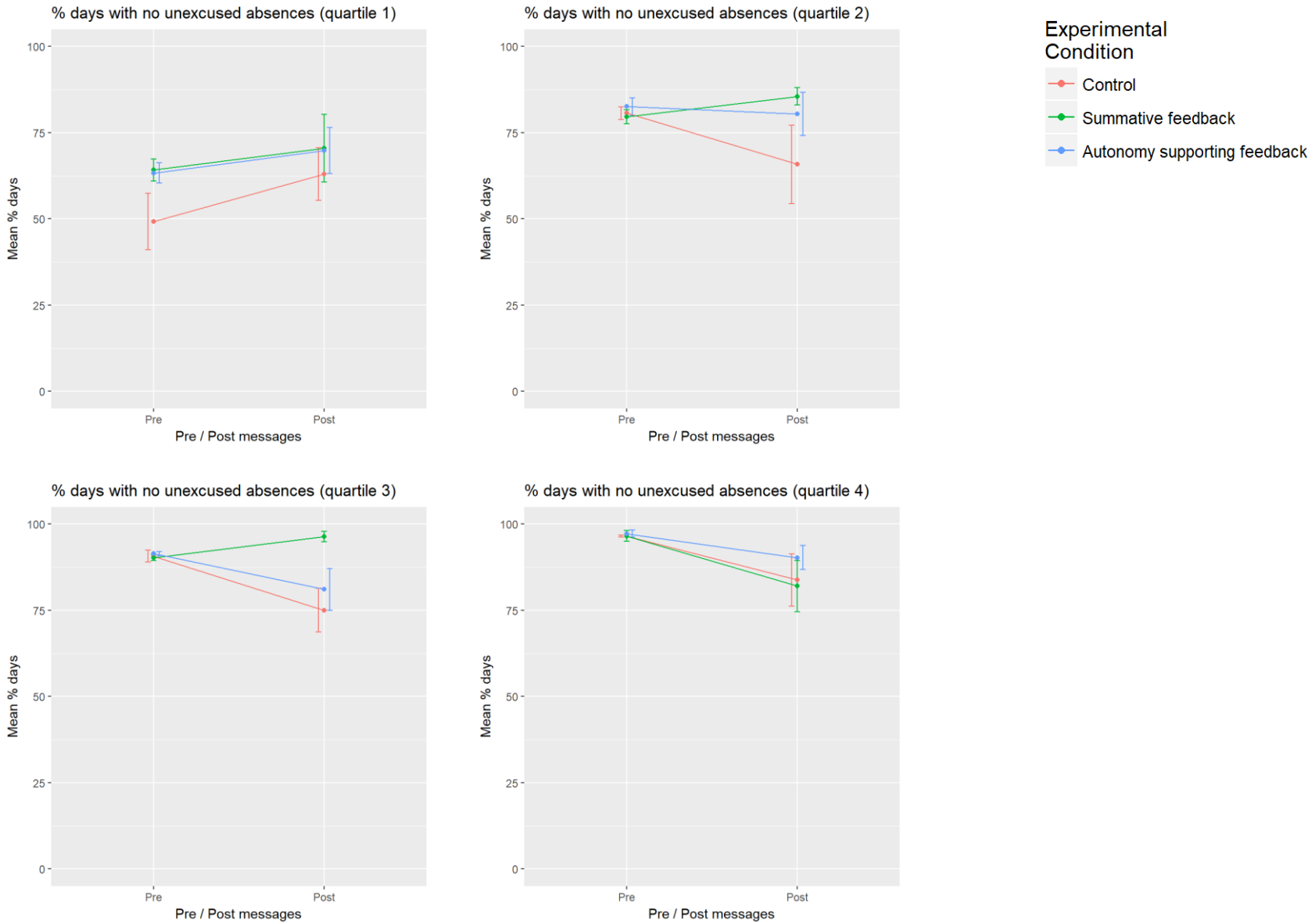

Figure 19: Study One - % days with no unexcused absences by pre-intervention attendance quartiles

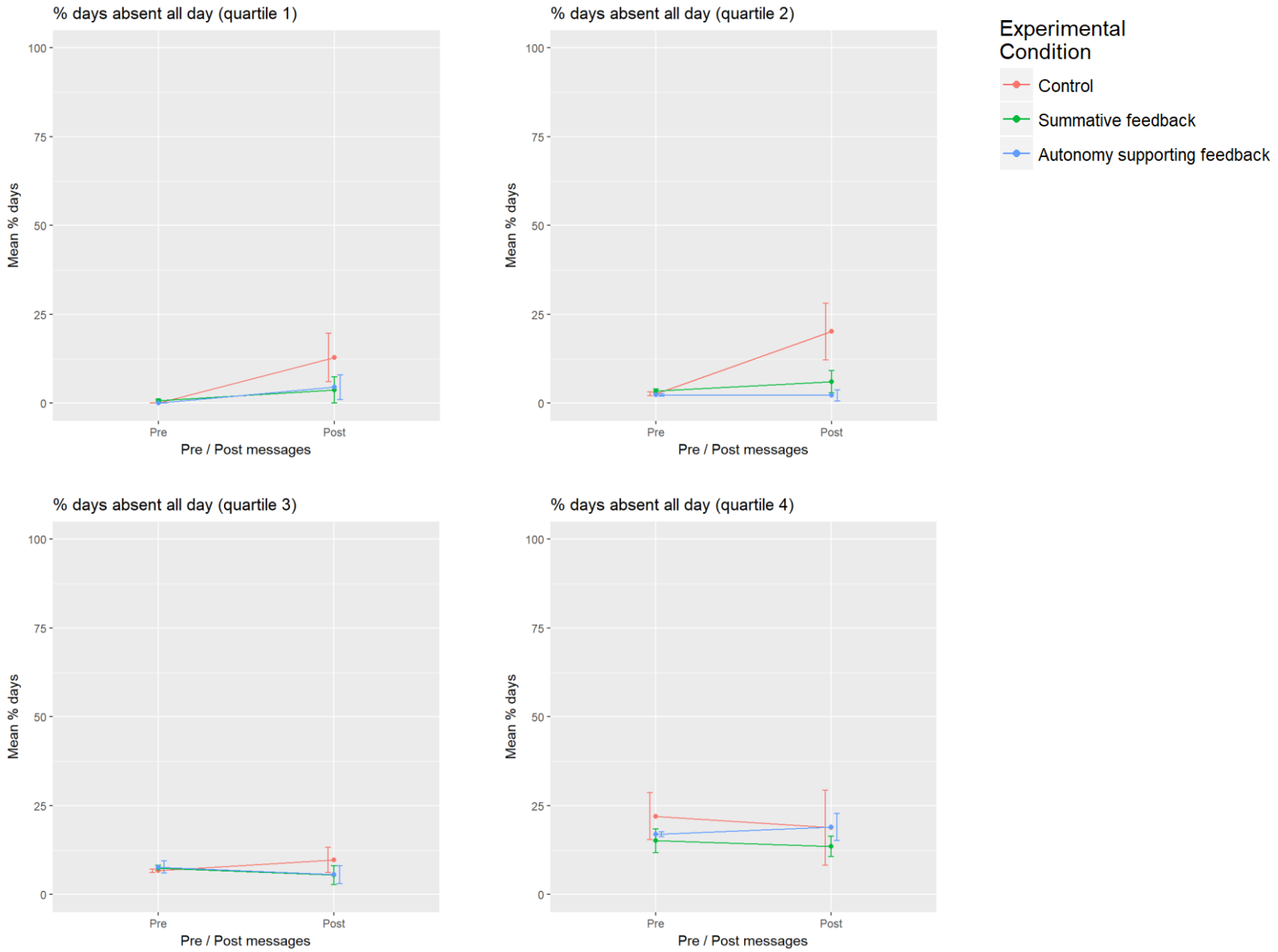

Figure 20 Study One - % days absent all day by pre-intervention attendance quartiles

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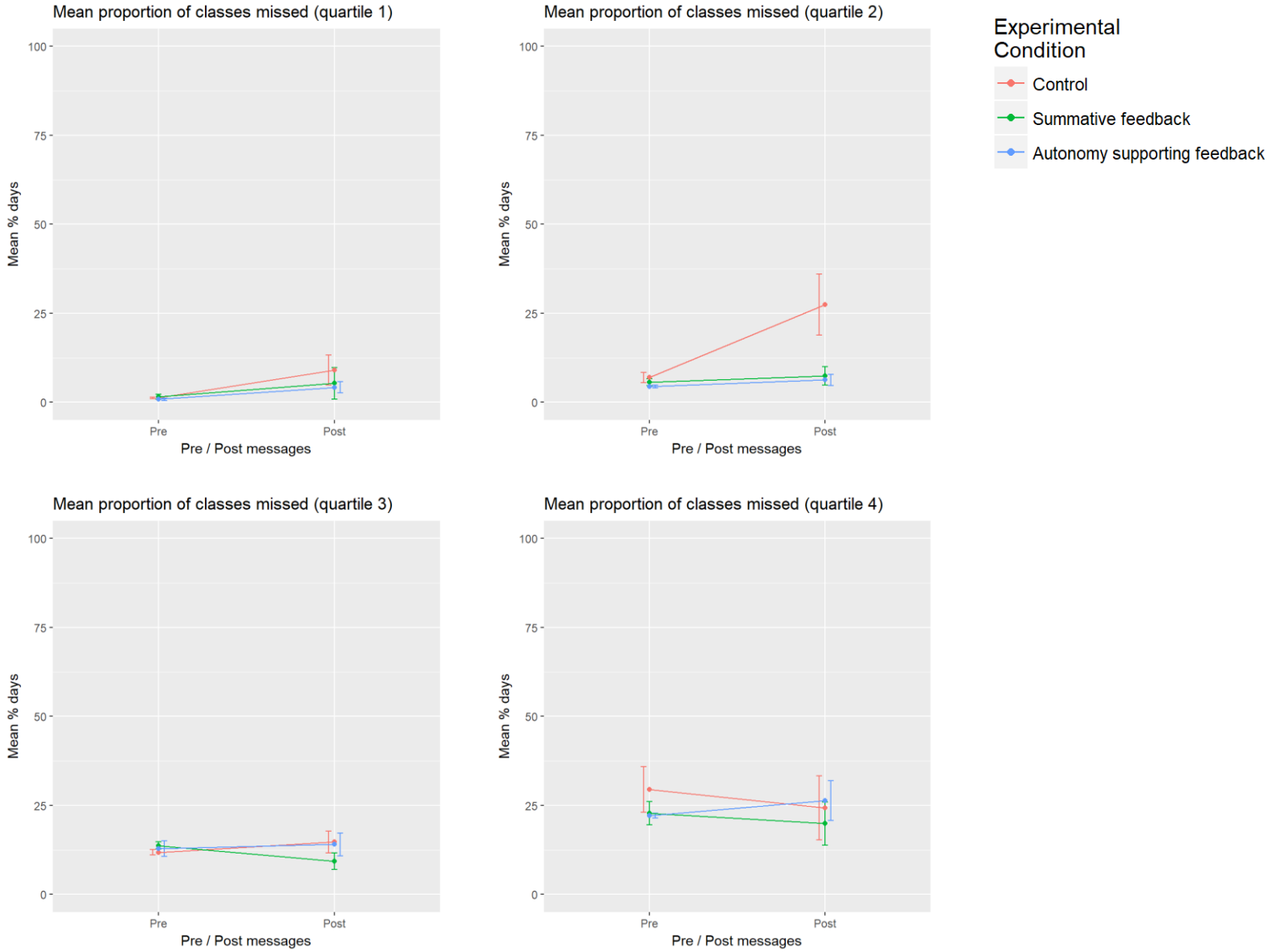

Figure 21: Study One - % classes missed by pre-intervention attendance quartiles

7.3.8.4 Spanish home language sample

Home language was found to be a significant moderator of the treatment effect with Spanish home language having a strong positive effect and other languages being neutral or negative (see section 7.3.7). A sample of the participants was taken that were identified as having Spanish as a home language and the analyses of the main effect were repeated on this sub-group.

7.3.8.4.1 All day absences: Percentage of days when absent all day (unexcused) - Spanish home language participants only

The average percentage of days when participants were absent all day with unexcused absences was higher in the control group (n= 15, M=22.32%, sd= 22.95) than either of the treatment groups (GRPH+AUTMY: n=15, M= 4.812%, sd=7.296 and GRAPHICAL: n=13, M=5.331%, sd=5.933) after exposure to the messages. See Figure 16. A two-way ANOVA analysis found the difference between the groups to be significant, $F(2,77) = 6.4$, p=0.003.

A post hoc Tukey test showed a significant difference between the CONTROL and GRPH+AUTMY groups (p= 0.004) and between CONTROL and GRAPHICAL (p=0.02) but not between GRPH+AUTMY and GRAPHICAL(p=0.9).

Cohen's d effect sizes of the groups were large when compared with the control and were statistically significant with 95% confidence intervals that did not include zero (GRPH+AUTMY /Control -1.0 and GRAPHICAL/Control -0.98). There was a negligible effect when comparing GRPH+AUTMY and GRAPHICAL. See Table 26.

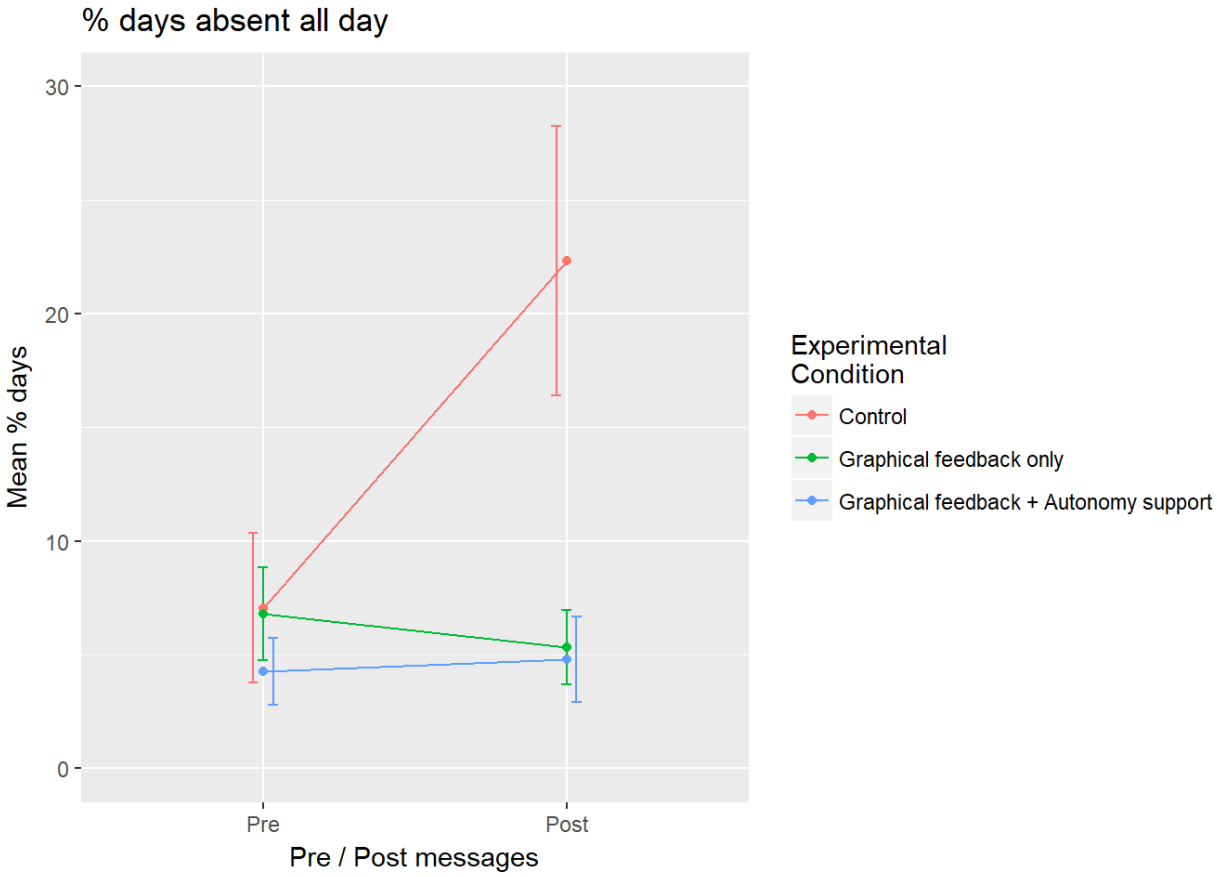

Figure 22: Study One – Attendance rate: Participants all day (unexcused)– Spanish home language comparing students in groups GRAPHICAL, GRPH+AUTMY and CONTROL

7.3.8.4.2 No absences: Percentage of days with no unexcused absences - Spanish home language participants only

The proportion of days with no unexcused absences showed a similar trend is similar but with smaller, but significant effect sizes and lower F scores in ANOVA. Attendance rates were lower in the control group (n=15, M=71.01%, sd=23.2) compared with the treatment groups (GRPH+AUTMY: n=15, M=85.54%, sd=11.36) and GRAPHICAL: n=13, M=86.18%, sd=11.59). See Figure 23. Two way ANOVA analysis did not show a significant difference between groups, $F(2,77) = 2.03$, $p=0.1$.

Cohen's d effect sizes were medium and large when comparing intervention groups with the control and confidence intervals almost did not include zero (GRPH+AUTMY /CONTROL 0.80 and

GRAPHICAL/CONTROL 0.81). Effect size was negligible when comparing GRPH+AUTMY and GRAPHICAL). See Table 26.

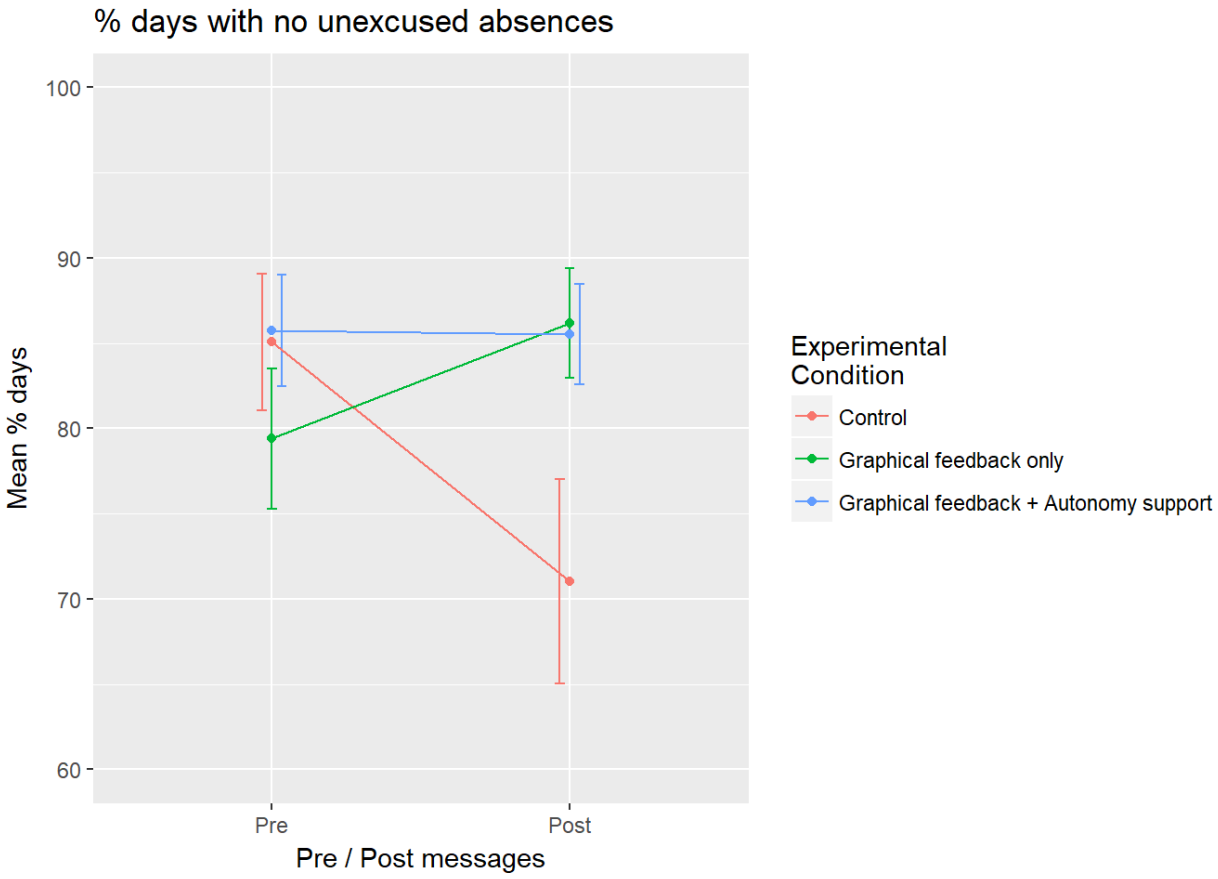

Figure 23: Study One – No absences – Proportion of days with no unexcused absences- Spanish home language participants comparing students in groups GRAPHICAL, GRPH+AUTMY and CONTROL

7.3.8.4.3 Classes missed: percentage of scheduled classes missed with unexcused absences - Spanish home language participants

When number of classes for which a student was scheduled was compared to the number of classes in which they were absent (unexcused) there is a similar pattern with higher average absence rates in the control group (n=15, M=22.73%, sd=22.70) compared with the treatment groups (GRPH+AUTMY: n=15, M=7.854%, sd=6.399 and GRAPHICAL: n=13, M=8.321%, sd=7.982). See Figure 24. Two-way ANOVA analysis found that the difference between the groups was significant, $F(2,77)=3.95$, p=0.02. A post hoc Tukey test showed a significant difference between the CONTROL and

GRPH+AUTMY groups (p= 0.02) but not between CONTROL and GRAPHICAL (p=0.1) or between GRPH+AUTMY and GRAPHICAL(p=0.8).

Cohen's d effect sizes were small (GRPH+AUTMY /Control 0.4 and GRAPHICAL/Control 0.3 with negligible effect sizes when comparing GRPH+AUTMY and GRAPHICAL). See Table 26.

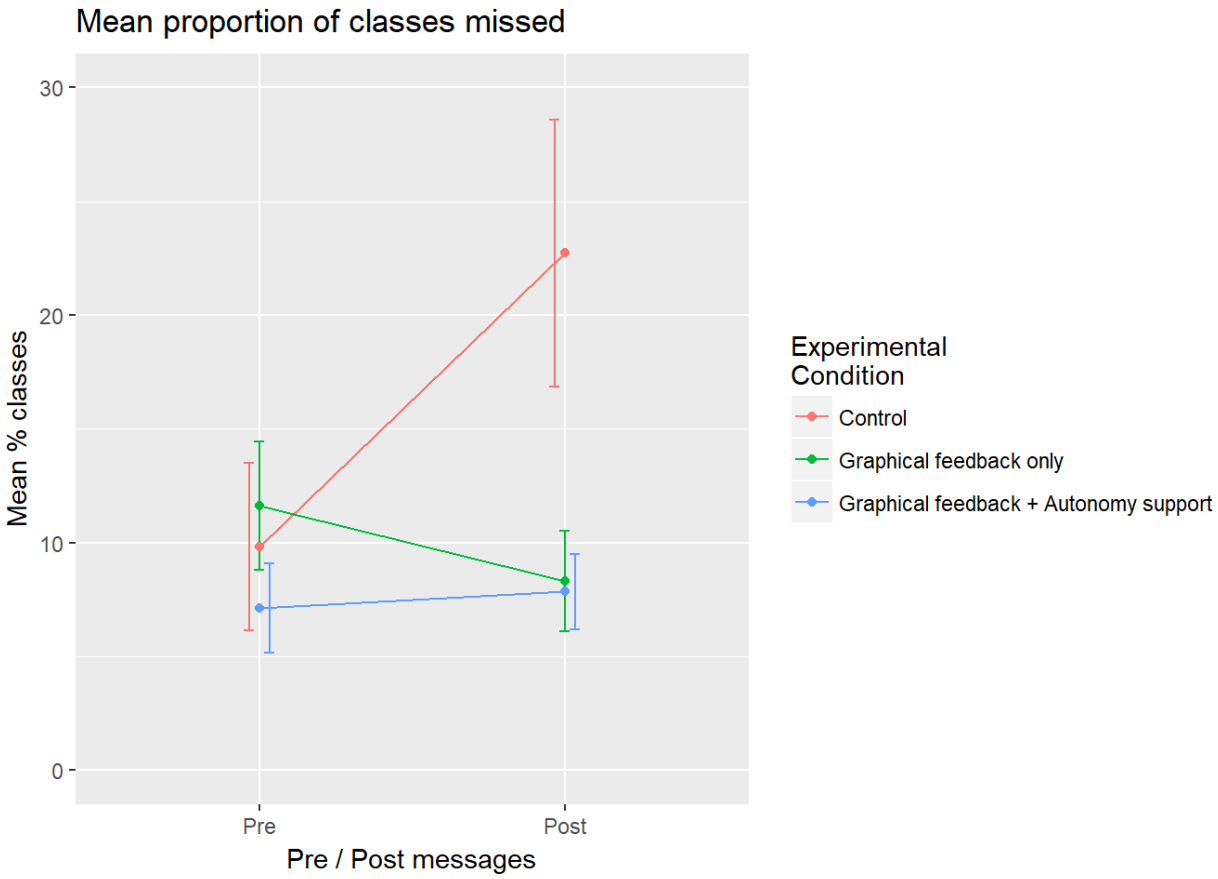

Figure 24: Study One – Percentage of classes missed (unexcused) - Spanish home language participants comparing students in groups GRAPHICAL, GRPH+AUTMY and CONTROL

		Treatment						ANOVA			Effect size (Cohen's d) (95% CI)
		GRPH+AUTMY		GRAPHICAL		Control					
		Pre (N=14) Mean (sd)	Post (N=15) Mean (sd)	Pre (N=13) Mean (sd)	Post (N=13) Mean (sd)	Pre (N=13) Mean (sd)	Post (N=15) Mean (sd)	F(2,77) Group	F(1,77) PrePost	F(2,77) Group * PrePost	
Experiment One	% days no unexcused absences	85.73 (12.25)	85.54 (11.36)	79.40 (14.88)	86.18 (11.59)	85.08 (14.47)	71.01 (23.20)	2.032	0.6275	**3.258 ***	**AUTMY/CON 0.80 (0.02 – 1.57** **FB/CON 0.81 (0.0 – 1.6)** AUTMY/FB -0.056 (-0.83 – 0.72)
	% days unexcused all day	4.277 (5.544)	4.812 (7.296)	6.806 (7.325)	5.331 (5.933)	7.059 (11.90)	22.32 (22.93)	**6.396 ****	3.335	**3.924 ***	**AUTMY/CON -1.0 (-1.8 – -0.23)** **FB/CON -0.98 (-1.8 – -0.16)** AUTMY/FB -0.077 (-0.86 – 0.70)
	% classes missed with unexcused absence	7.127 (7.304)	7.854 (6.399)	11.63 (10.14)	8.321 (7.982)	9.832 (13.25)	22.73 (22.70)	**3.95 ***	0.21	0.05790	**AUTMY/CON -0.89 (-1.58 – -0.11)** **FB/CON -0.82 (-1.6 – -0.011)** AUTMY/FB -0.065 (-0.84 – 0.71)

* p<.05

** p<.005

Table 26: Study One – Perfect and partial attendance rates of Spanish home language participants comparing students in groups GRAPHICAL, GRPH+AUTMY and CONTROL

7.3.8.4.4 Questionnaire measures – Spanish home language only

There was no significant difference in any of the secondary measures between groups before the intervention. However, there was a significant difference of negative moods (anger, confusion, depression, fatigue and tension) between the groups after the messages were sent. See Table 27. Tukey's multiple comparisons of means confirmed greater levels ($p < .05$) of anger, depression, and fatigue in the graphical feedback (GRAPHICAL) group when compared with the control group (p=0.02, p=0.04, p=0.03 respectively) and depression when compared with the group receiving additional autonomy supporting feedback, GRPH+AUTMY (p=0.02). See Table 28.

		Before sending messages			After sending messages		
		CONTROL	GRAPHICAL	GRPH+AUTMY	CONTROL	GRAPHICAL	GRPH+AUTMY
	N	15	13	15	9	8	12
	Self esteem	4.75 (1.60)	4.39 (1.66)	5.00 (1.62)	5.38 (1.60)	5.57 (1.62)	5.09 (1.76)
		F(2,36)=1.285, p=.6194			F(2,23)=0.1854, p=.832		
	Truancy ladder	8.04 (1.63)	8.00 (1.528)	8.933 (1.28)	8.67 (1.66)	8.5 (1.41)	8.3 (1.57)
		F(2,37)=1.807, p=.1783			F(2,24)=0.1323, p=.8767		
	Autonomy	2.94 (1.32)	3.56 (1.56)	3.27(1.11)	2.85 (1.91)	2.79 (1.53)	2.79 (1.68)
		F(2,38)=0.7231, p=.4918			F(2,26)=0.00357, p=.9964		
Mood survey	**Anger**	0.696 (1.12)	0.85 (0.9594)	0.450 (0.656)	**0.204 (0.17)**	**1.16 (0.92)**	**0.542 (0.690)**
		F(2,39)=0.6651, p=.520			**F(2,26)=4.506, p=.02089**		
	Confusion	0.607 (0.64)	1.013 (0.918)	0.617(0.5287)	0.444(0.464)	0.875(0.756)	0.646 (0.644)
		F(2,39)=1.453, p=.2464			F(2,26)=0.9929, p=.3841		
	Depression	0.50 (1.00)	0.673(1.082)	0.3167(0.53)	**0.278(0.491)**	**0.938(0.788)**	**0.229 (0.328)**
		F(2,39)=0.5587, p=.5765			**F(2,26)=4.795, p=.01688**		
	Fatigue	1.25 (0.99)	1.69 (1.173)	1.35 (0.958)	**0.556 (0.410)**	**1.656 (1.141)**	**1.00 (0.853)**
		F(2,39)=0.6695, p=.5178			**F(2,26)=3.639, p=.04041**		
	Tension	0.827 (0.74)	0.942 (0.925)	0.783 (0.743)	0.694 (0.846)	1.312 (0.998)	0.708 (0.730)
		F(2,39)=0.1432, p=.867			F(2,26)=1.512, p=.2392		
	Vigour	1.93 (1.14)	2.25 (1.01)	2.02 (1.08)	2.39 (0.985)	2.06 (0.678)	2.10 (1.05)
		F(2,39)=0.3096, p=.7355			F(2,26)=0.3305, p=.7215		

Table 27: Study One – Questionnaire data – Spanish home language participants only

7.3 - Study One: An evaluation of an SMS-based autonomy supporting feedback intervention on school attendance rates - Results

In the Acceptability measure completed by participants who received messages, participants receiving the feedback plus autonomy support messages reported that they "enjoyed receiving the messages" significantly more than those on receiving the feedback only messages, $F(1,14)=6.6$, p=0.02 (AUTONOMY+FB: n=10, M=1.5, sd=0.53; GRAPHICAL: n=6, M=2.5, sd=1.1). There were no significant differences in other measures. See Table 29.

	GRAPHICAL vs CONTROL		**GRPH+AUTMY vs CONTROL**		**GRPH+AUTMY vs GRAPHICAL**	
	Difference (Conf. Interval)	**p**	**Difference (Conf. Interval)**	**P**	**Difference (Conf. Interval)**	**P**
Anger	**0.953** **0.155– 1.75**	**0.02**	0.338 -0.385 – 1.06	0.5	-0.615 -1.36 – 0.134	0.1
Confusion	0.431 -0.389 – 1.190	0.4	0.201 -0.488 – 0.890	0.8	-0.229 -0.942 – 0.484	0.7
Depression	**0.660** **0.0131 – 1.306**	**0.04**	-0.0486 -0.635 – 0.538	1.0	**-0.708** **-1.316 – -0.101**	**0.02**
Fatigue	**1.10** **0.0832 – 2.19**	**0.03**	0.444 -0.479 – 1.368	0.5	-0.656 -1.61 – 0.300	0.2
Tension	0.618 -0.402 – 1.64	0.3	0.0138 -0.912 – 0.939	1.0	-0.604 -1.56 – 0.354	0.3
Vigour	-0.326 -1.45 – 0.810	0.8	-0.292 -1.32 – 0.739	0.8	0.035 -1.03 – 1.10	1.0

Table 28: Study One – Tukey's comparison of means - Mood measure after intervention - Spanish home language participants only

	GRAPHICAL Mean (sd)	GRPH+AUTMY Mean (sd)	ANOVA
N	6	10	
Did you enjoy receiving the messages?	**2.5 (1.1)**	**1.5 (0.53)**	**F(1,14)=6.56, p=0.02**
How useful were the messages that you received?	1.7 (1.0)	1.9 (1.4)	F(1,14)=0.118, p=.0.7
How easy were messages to understand?	1.8 (1.3)	1.3 (0.71)	F(1,14)=912, p=0.4
What did you think about how often you received messages?	4.2 (1.6)	3.1 (1.7)	F(1,14)=1.58, p=0.2
How often did you read the messages?	1.8 (1.3)	2.1 (2.0)	F(1,13)=0.0909, p=0.8
How much trouble were the messages that you received?	3.0 (1.5)	2.0 (1.2)	F(1,14)=2.02, p=0.2
What did you think about the text in the messages? (Interesting or boring)	2.7 (1.5)	2.1 (1.5)	F(1,13)=0.478, p=0.5
Did you like the time that the messages were sent?	2.2 (1.5)	2.3 (1.7)	F(1,14)=0.0253, p=0.9
Do you think you attended more?	2.3 (1.4)	2.2 (1.4)	F(1,13)=0.0232, p=0.9
Do you want ro receive messages next year?	1.5 (0.84)	1.2 (0.67)	F(1,13)=0.512, p=0.5
Recommend at this school	1.0 (0)	1.5 (0.85)	F(1,14)=2.02, p=0.2
Recommend at regular high school	1.2 (0.41)	1.2 (0.63)	F(1,14)=0.0132, p=0.9
Question 1 correct			
Yes	3 (50%)	6 (60%)	
No	3 (50%)	4 (40%)	
Question 2 correct			
Yes	2 (33%)	3 (30%)	
No	4 (66%)	7 (70%)	

Table 29: Study One – Acceptability Questionnaire Mean Scores - Participants with Spanish home language only

7.3.8.4.5 Preferred Language

The distribution of preferred language for messages, elected by student on registration in the trial (see Table 18)was compared and Fisher's Exact Test used to check for a non random distribution. There was no significant difference between the groups (p=0.07). See Table 30.

	All participants	Control	GRAPHICAL	GRPH+AUTMY	Fisher's Test
English	26 (70.2%)	12 (80.0%)	4 (40%)	10 (83%)	p=0.07
Spanish	11 (29.7%)	3 (20%)	6 (60%)	2 (17%)	

Table 30: Study One – Choice of language for message delivery by group - Spanish home language only

7.4 Summary of findings

The results of this study offer a number of insights into the effect of autonomy supporting messages and graphical feedback delivered by SMS on participant behaviour. Hypothesis 1, that messages containing graphical feedback would reduce absenteeism was confirmed. Hypothesis 2, that messages containing additional autonomy supporting text would be still more effective was not. Hypothesis 3, that messages containing autonomy supporting text would increase perceived autonomy among recipients was not confirmed. The results appear to indicate that adding autonomy supporting tailored message text to simple graphical feedback on behaviour does not make significant improvements to attendance rate but post-hoc analyses suggest that it may make the intervention more acceptable to some students, particularly those for whom their primary language at home is Spanish.

The data show that participants who received the SMS messages missed less school with unexcused absences than those who did not. When measuring the mean percentage of days absent all day, students receiving messages missed less than half as many days as the control group (section 7.3.3.1).

The effect size of sending autonomy supporting messages (GRPH+AUTMY) over no messages (CONTROL) was -0.60 when measuring mean percentage of days absent all day from school with a 95% confidence interval that did not include zero (95% CI: -1.2 – -0.028). This can be visualised as follows: 73% of

the control group had a higher absence rate than the average student receiving messages (Coe 2002). The effect size for students receiving feedback only (GRAPHICAL) was -0.52 (95% CI: -1.1 – 0.069) , and the percentage in the control group with higher absence rate would be 69% (Coe 2002). There was a negligible differences in effect size when comparing the two groups. Analysis of groups stratified by attendance rates prior to the intervention shows that the intervention best supported attendance among students in the second and third quartiles.

Results from the acceptability measure showed no significant difference between groups in response to the intervention. All scores were favourable. Qualitative analysis of the free response questions show an interesting trend with both groups showing appreciation for the ability to keep track of their attendance.

Moderation analysis revealed a significant relationship between students Home Language and the effectiveness of the intervention. Classification of home language is self-reported by families when they register their child in school in answer to the question “What language is spoken in your home most of the time?” (TEA 2017). It should be noted that a student’s Home Language may not be the same as their preferred language as can be seen in section their choice of message language: 70% of these students chose to receive messages in English (see section 7.3.8.4.5).

The interaction of Home Language with all day absence was negative among participants in the no treatment control group with the regression coefficient predicting absence rates to be 16% higher among students with Spanish as their home language than their English control group counterparts (p=.0009) but 22% lower in the feedback only group (p=.001) and 21% lower in the autonomy supporting group (p=.001). This confirms previous research that has found non-English speakers to have higher rates of absenteeism (Utah Education Policy Center 2012).

When a sample of Spanish home language students was analysed, the same trends appear as in the full sample, but the effect was much stronger, with effect sizes of -1.0 (95% CI: -1.8 – 0.23) (GRPH+AUTMY) and 0.98 (95% CI: -1.8 – 0.16) (GRAPHICAL) when compared with the no treatment group (CONTROL). These

describe an effect such that approximately 84% of the control group would have a higher absence rate than the average participant receiving messages (Coe 2002)

Analysis of the secondary measures among Spanish home language participants also yielded interesting results. As with the whole sample, there was no significant difference between groups before the intervention but students receiving the feedback only messages showed significantly more negative mood scores than either the no treatment control or autonomy supporting feedback groups, see Table 27.

7.5 Discussion

The results show that adding autonomy supporting text to the graphical feedback did not have a significant effect on attendance rate but that both interventions increased the rate of attendance for at least part of the day. The autonomy supporting text may however have made the feedback more acceptable to some students. This is suggested in the post hoc analysis of students coming from homes where the primary language is Spanish where negative mood and enjoyment measures revealed a significant difference between the two intervention groups. This would be an interesting area for further research as this group of students is especially likely to be absent (see section 2.4).

The qualitative study of responses to the prompts in the acceptability questionnaire revealed that many participants found it helpful to track their attendance, some suggesting that they would not otherwise know how much school they had missed. This echoes theories around directing attention in feedback intervention first raised by Kluger and DeNisi (1996) and in the 'tunnelling' metaphor in Scarcity Theory (Mullainathan and Shafir 2013). The Fogg Behaviour Model (Fogg 2009) describes a Trigger component to behaviour change technologies which should be delivered at the time that the recipient needs to choose a target behaviour.

The intervention was designed to encourage students to "show up" to school more often. Messages were written to praise students equally for coming to school for part of the day or for perfect attendance, though days of "perfect" attendance were specifically recognised and praised. The results reflect this goal – partial day attendance was higher than perfect attendance. Reviewing which periods were missed shows that students most often missed

first period (see section 7.3.8.1). In the next chapter a second study is described that attempted to increase the effectiveness of the intervention by targeting the early morning absences by sending the messages at the time that participants woke in the morning.

8 Study Two: An early morning repeat evaluation of SMS-based autonomy supporting feedback intervention on school attendance rates

8.1 Introduction

In the previous study (chapter 7), students receiving feedback messages missed less school due to unexcused absences than those in the control group, see Table 20. However, there were no significant differences in effect on attendance between messages containing only graphical feedback and those containing additional autonomy supporting text. It was found that the first class of the day was most frequently missed (see section 7.3.8.1).

In the field of formative feedback in education studies surrounding the timing of feedback find that immediate feedback reduces repetition of errors while delayed feedback improves retention of new information (Shute 2008). Theories of behaviourism (Skinner 1953) also support immediate delivery of feedback when attempting to modify behaviour. The recent developments of computer driven behaviour change interventions have revealed inadequacies in our theories of behaviour change, particularly as the offer a new dimensionality to behaviour change - time and the new, dynamic nature of adaptive interventions (Riley et al. 2011). Likewise, in a 2016 review of self-monitoring devices focussed on physical activity (e.g. Fitbit), Sanders et al (2016) note the paucity of research surrounding the timing of feedback. They suggest that feedback needs to be given at "in a manner that is context aware" or at the time when the recipient needs to act. This also reflects the notion that a person's behaviour is not only a reflection of their subconscious and complexes, but also of their environment (which can be modified through an intervention) as posited by Social Cognitive Theory (Bandura 2004). The Fogg Behaviour Model (Fogg 2009) claims that prompts are most effective when timed to "trigger" action.

This study changed the focus of the intervention in the first study from a review of the day's attendance delivered at the end of the day to one sent the following day at the time that each participant was considering whether to go to school or not – when they woke up. Each participant was asked during recruitment at what time

they needed to get up in the morning to arrive at school in time for their first class and messages were sent at that time each day.

As described in section 7.3.5.1, some shortcomings were identified in administering the secondary measure questionnaires in the first study and these were addressed to improve their validity. These are detailed in the measures section below.

All other aspects of the study are identical to the first.

This experiment evaluates the effectiveness of the intervention and tests the following hypotheses:

1. Sending graphical feedback on recent attendance by SMS will increase attendance rates when compared to a no message control group.
2. Sending graphical feedback together with autonomy supporting messages will increase attendance rates when compared with sending only feedback and with a no message control group.
3. Sending autonomy supporting messages will increase perceived autonomy of recipients when compared to participants receiving messages without autonomy supporting components and with a no message control group.
4. Sending messages at the time that students wake up to go to school will result in higher rates of attendance than those found in the first study where messages were sent at the end of the school day.

8.2 Methods

The sample in this study (N=70) included 38 boys and 32 girls, aged between 15 and 20 who were recruited at the same “alternative” high school in Texas, USA as Study One (chapter 7) and Pilot Study (chapter 6).

8.2.1 Research design

The research design, sampling, inclusion and exclusion criteria and randomization procedures were identical to Study One. Participants were recruited from 26 August 2016 to 16 November 2016 as students enrolled in school.

8.2.1.1 Participant characteristics

Overall, the sample was comprised of students from a low socioeconomic status background. The majority (84%) of participants were classified as economically disadvantaged by the school district. Those students coming from homes with an income below 130% of the poverty level receive free school lunch. Most (81%) participants received free lunch and 3% received subsidized lunch.

All participants were labelled as "at-risk" according to the Texas Education Authority definition (Texas Education Code 2013).

8.2.1.2 Sample size

A power analysis of Study One found that a minimum sample 19 for each of three groups was needed to provide 80% power to detect an effect similar to that in experiment one ($d = 0.4176$) at $p = 0.05$.

8.2.1.3 Ethical approval

The school principal, as gatekeeper, gave consent for the study to take place. Ethical approval by Coventry University was obtained before starting the study. Students signed a consent form and provided their own cell phone number to indicate that they consented to participate.

8.2.2 Measures

The measures were identical to those used in the first study (see section 7.2.2) with the following changes made based on the researcher's experience in administering the first study (see section 7.3.5.1).

8.2.2.1 Single item self esteem

While gathering data for Study One, the researcher noticed that not all students knew what "self-esteem" meant. Therefore, for the second study, a sentence defining self-esteem, composed by the researcher, was included in the same single item measure. The definition was based on the ten items of the Rosenburg instrument (Rosenberg 1989) and read "Self-esteem is the belief that you are at least as good as other people and you are satisfied with yourself".

8.2.2.2 Wakeup time

In order to send the messages closer to the time that students made the decision whether to attend school or not, the question "What time do you need to wake up to get to school in time for your first class?" was included in the baseline questionnaire. This information was input into the application.

8.2.2.3 Translation

All questionnaire items were translated into Spanish using Google translate and then reviewed by a bilingual school administrator whose first language was Spanish. Participants were offered a free choice between English and Spanish versions.

8.2.3 Intervention procedure

The intervention messages were the same as in the first study (section 6.5.1 and 6.5.3). However, instead of being sent at the end of the day, the messages were sent at the time that participants had said that they had to wake up in time to get to school on time. Where participants claimed to wake up earlier than 6am, the messages were sent at 6am to avoid sending messages to students at what could considered inappropriate times.

As in the first main study, data files for participant schedules and attendance were generated at the end of each school day and uploaded to the application which generated the messages and marked them with the individual participants' wake up time. The messages were automatically sent at the designated time the following day.

Message text was changed only as much as was necessary to make the messages refer to the previous school day's attendance rather than "today" as in the first study.

Technical changes were also made to enable the application to schedule and send multiple messages at the same time, while in the first study it could only send one message every two minutes. The images representing student attendance were generated at the time that the message was created (in the evening after school) and stored on an Amazon S3 website for access by the Twilio messaging gateway upon sending instead of being generated dynamically as each message was sent.

8.2.3.1 Intended exposure and time span

The intervention began on 26 October 2016 and ended on 9 December 2016 to allow time for completing the final measures questionnaires before the winter vacation.

8.3 Results

8.3.1 Participant flow

Figure 25: Study Two – CONSORT 2010 Flow of participants
(Moher et al. 2010)

8.3.1.1 Treatment fidelity

Callbacks from the Twilio service confirmed whether messages had been sent, delivered or failed. Each time messages were sent, the researcher checked the callbacks and where messages had not sent successfully, they were resent as described.

Some network errors at the Twilio messaging service prevented delivery of messages to a number of participants. Delivery was only substantially affected for two students with 13 and 14 messages undelivered (one student from group SDT and one from FB). These two students' attendance data were excluded from analysis from the date that they stopped receiving the intervention messages. Three other students experienced some

message delivery failure – one missed one message out of 26 and one missed two messages out of 26 and one missed 2 of 22 total messages sent. All of their attendance data was included for analysis. See Table 31.

Participant group	Number of messages attempted	Number of messages undelivered	
GRAPHICAL	26	1	
GRAPHICAL	25	14	Attendance excluded from analysis after 11/14/2016
GRPH+AUTMY	27	13	Attendance excluded from analysis after 11/16/2017
GRPH+AUTMY	26	2	
GRPH+AUTMY	22	2	

Table 31: Study Two – Breakdown of undelivered messages per student

Three participants reported at the end of the trial that they had not received any messages and it was discovered that they had given an incorrect cellphone number. The participants were excluded from data analysis (all three from group GRAPHICAL). Another participant reported that they had only received only approximately a week of messages before his number was disconnected and so was also excluded from analysis (from group GRPH+AUTMY); the participant completed an acceptability questionnaire based on the experience they had with the intervention.

8.3.1.2 Participant withdrawals

No participants asked to withdraw from the trial and two sent STOP messages that automatically stopped any further messages being sent to them. Their attendance data was included in the analysis up until they sent their STOP request but not afterwards when they were no longer receiving the intervention.

Nine students left the school during the intervention. Their attendance data was included up until the day that their enrolment ceased.

8.3.1.3 Exposure to intervention

Students joined and left the study throughout the trial period. ANOVA analysis of the number of days of participation during the time that messages were sent was made to reject the hypothesis that any difference between groups in attendance after the intervention was due to different periods of measurement or levels of exposure to the intervention F(2,67)=0.610, p=0.5. See Table 32.

	GRPH+AUTMY	GRAPHICAL	CONTROL	ANOVA
N	27	20	23	
Days of exposure Mean (sd)	29.70 (5.763)	29.40 (5.897)	27.74 (7.944)	$F(2,67)=0.610$, $p=0.5$

Table 32: Study Two – Days enrolled in study period by group

8.3.2 Baseline data

8.3.2.1 Baseline – Demographics

There were no significant differences in demographic measures between groups at baseline. See Table 33.

	All	GRPH+AUTMY	GRAPHICAL	Control	ANOVA or Fisher Test P
N	70	27	20	23	
Sex					
Male	38 (54.3%)	13 (48.1%)	13 (65.0%)	12 (52.2%)	0.5
Female	32 (45.7%)	14 (51.9%)	7 (35.0%)	11 (47.8%)	
Age (years)	17.7 (0.90)	17.7 (0.92)	17.7 (0.48)	17.7 (1.2)	F(2,67)=0.044 p=0.1
< 18:	49 (70.0%)	18 (66.7%)	17 (85.0%)	14 (60.9%)	0.2
>= 18:	21 (30.0%)	9 (33.3%)	3 (15.0%)	9 (39.1%)	
Federally identified race					
American Indian or Alaskan Native	13 (18.6%)	8 (29.6%)	3 (15.0%)	2 (8.7%)	
American Indian or Alaskan Native / White	1 (1.4%)	0 (0.0%)	1 (5.0%)	0 (0%)	0.5686
Black or African American	8 (11.4%)	3 (11.1%)	2 (10.0%)	3 (13.0%)	
White	48 (68.6%)	16 (59.3%)	14 (70.0%)	18 (78.3%)	
Hispanic/Latino					
Yes	58 (82.9%)	21 (77.8%)	17 (85.0%)	20 (87.0%)	0.7
No	12 (17.1%)	6 (22.2%)	3 (15.0%)	3 (13.0%)	
Grade					
9th	15 (21.4%)	7 (25.9%)	2 (10.0%)	6 (26.1%)	
10th	12 (17.1%)	5 (18.5%)	1 (5.0%)	6 (26.1%)	0.1
11th	18 (25.7%)	6 (22.2%)	5 (25.0%)	7 (30.4%)	
12th	25 (35.7%)	9 (33.3%)	12 (60.0%)	4 (17.4%)	
Low socioeconomic status					
No	11 (15.7%)	7	1	3	0.2
Yes	59 (84.3%)	20	19	20	
Free lunch	57 (81.4%)	18	19	20	
Reduced price lunch	2 (2.8%)	2	0	0	
Receiving special education services					
Yes	7 (10.0%)	3 (11.1%)	2 (10.0%)	2 (8.7%)	1.000
No	63 (90.0%)	24 (88.9%)	18 (90.0%)	21 (91.3%)	
At risk					
Yes	70 (100.0%)	27 (100.0%)	20 (100.0%)	23 (100.0%)	-
No	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	
Years since identification as at risk	2.71 (2.3)	3.0 (2.2)	2.3 (2.3)	2.8 (2.4)	F(2,66)=0.55, p=0.6
Years since entering 9th grade	2.67 (0.85)	2.8 (0.97)	2.9 (0.56)	2.4 (0.86)	F(2,67)=2.2, p=0.1
Riding the bus					
Yes	15 (21.4%)	5 (18.5%)	6 (30.0%)	4 (17.4%)	0.6
No	55 (78.6%)	22 (81.5%)	14 (70.0%)	19 (82.6%)	
Home language					
English	41 (58.6%)	19 (70.4%)	12 (60.0%)	10 (43.5%)	
Spanish	28 (40.0%)	8 (29.6%)	7 (35.0%)	13 (56.5%)	0.1
Other	1 (1.4%)	0 (0.0%)	1 (5.0%)	0 (0.0%)	
Primary language					
English	44 (62.9%)	19 (70.4%)	14 (70.0%)	11 (47.8%)	
Spanish	25 (35.7%)	8 (29.6%)	5 (25.0%)	12 (52.2%)	0.1
Other	1 (1.4%)	0 (0.0%)	1 (5.0%)	0 (0.0%)	
Days of attendance records between start of semester and start of intervention	30.4 (14.0)	29.8 (13.4)	29.2 (14.5)	32.2 (14.6)	F(2,58)=0.26, p=0.8

Table 33: Study Two – Baseline participant characteristics

8.3.2.2 Baseline - Attendance

Where attendance data was available for the period between August 2016 and the start of the intervention on 26 October 2016 was available, attendance rates were compared and ANOVA analysis found that there was no significant difference between the groups for all day absenteeism, F(2,58) = 0.093, p=0.9, no unexcused absences. F(2,58) = 0.188, p=0.8 or proportion of classes missed, F(2,58)=0.955, p=0.5. See Table 34.

	N	% days absent all day (unexcused) Mean % (sd)	% days with no unexcused absences Mean % (sd)	% classes missed with unexcused absences Mean % (sd)
Feedback + autonomy support (GRPH+AUTMY)	23	6.65 (9.29)	74.83 (25.74)	14.08 (14.24)
Feedback only (GRAPHICAL)	17	5.98 (8.59)	78.89 (17.0)	12.90 (1.52)
Control	21	7.58 (15.26)	76.26 (17.13)	13.01 (15.01)
ANOVA		F(2,58) = 0.093, p=0.9	F(2,58) = 0.188, p=0.8	F(2,58) = 0.955, p=0.5

Table 34: Study Two – Comparison of attendance rates before intervention (where data was available)

8.3.2.3 Baseline – Secondary measures

ANOVA analyses were made of the scores on the mood, single item self-esteem, perceived autonomy at school and truancy ladder measures and no significant differences were found between the groups. See Table 38 in section 8.3.5.

8.3.2.4 Preferred language

Most participants chose English as the language of delivery for their messages (94%). The Fisher test showed no significant difference between the language choices of the groups. See Table 35.

	All participants	Control	GRAPHICAL	GRPH+AUTMY	Fisher Test
English	65 (94%)	20 (87%)	19 (95%)	26 (96%)	0.5
Spanish	5 (6%)	3 (13%)	1 (5%)	1 (4%)	

Table 35: Study Two – Choice of language for message delivery by group

8.3.3 Hypothesis 1

Sending feedback on recent attendance to students by SMS will increase attendance rates when compared to a no message control group.

There was no significant difference between groups receiving feedback messages and those in the no message control group in any the three measures of attendance. The hypothesis was not supported.

8.3.3.1 Whole days missed

There was no significant difference between groups' absence rates when measuring the proportion of whole days missed with unexcused absences, $F(1,127)=0.38$, $p=0.5$. Cohen's d effect size was negligible. See Figure 26 and Table 36.

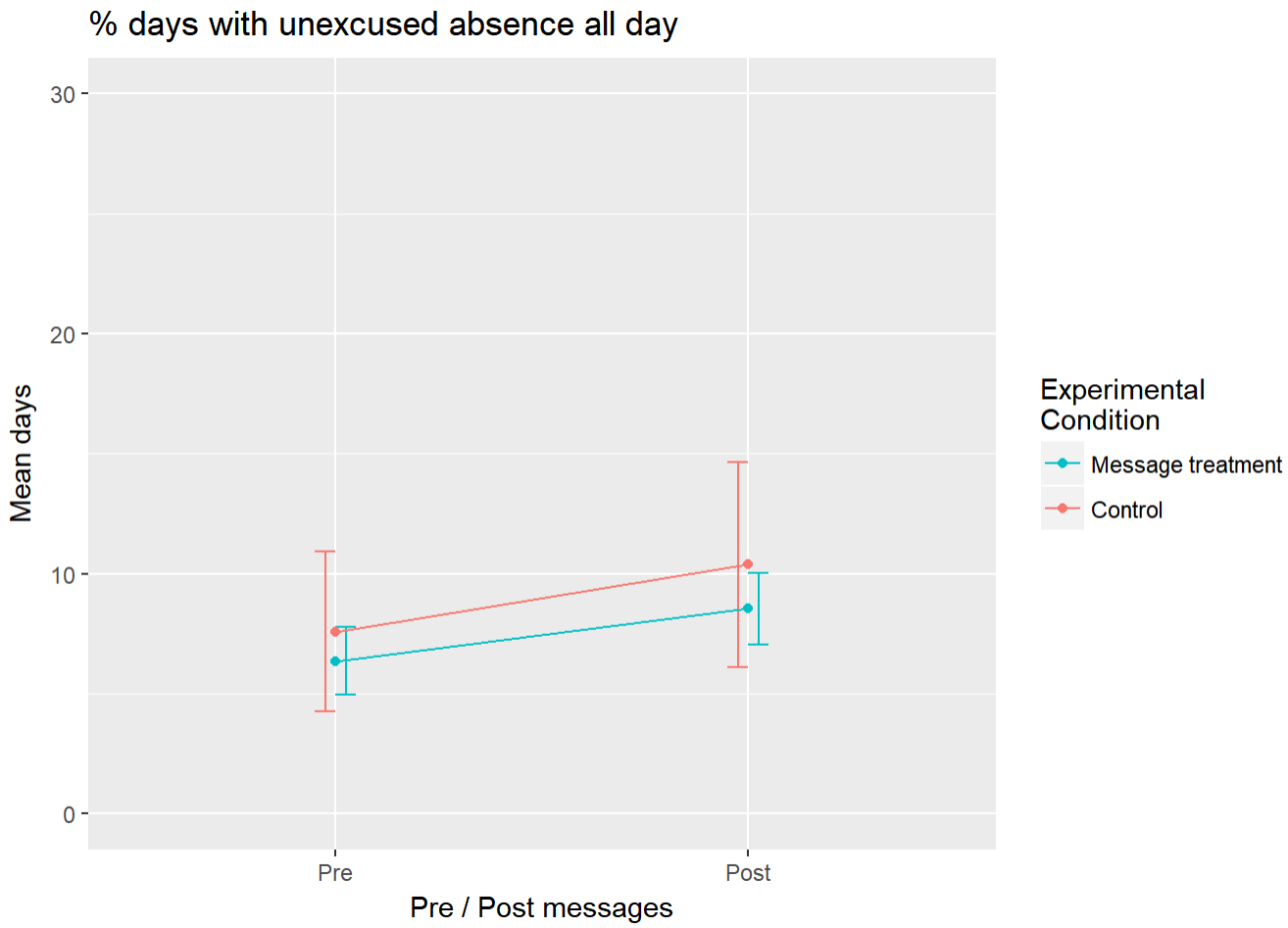

Figure 26: Study Two – Absent all day - combined experimental groups comparing all students receiving messages (GRPH+AUTMY and GRAPHICAL) with CONTROL

8.3.3.2 Days with no absences

There were no significant differences between groups' attendance rates when measuring the proportion of days missed with no unexcused absences, F(1,127)=1.2, p=0.3. Cohen's d effect size was small , d= 0.20 (95% CI: -0.11 – 0.51). See Figure 27 and Table 36.

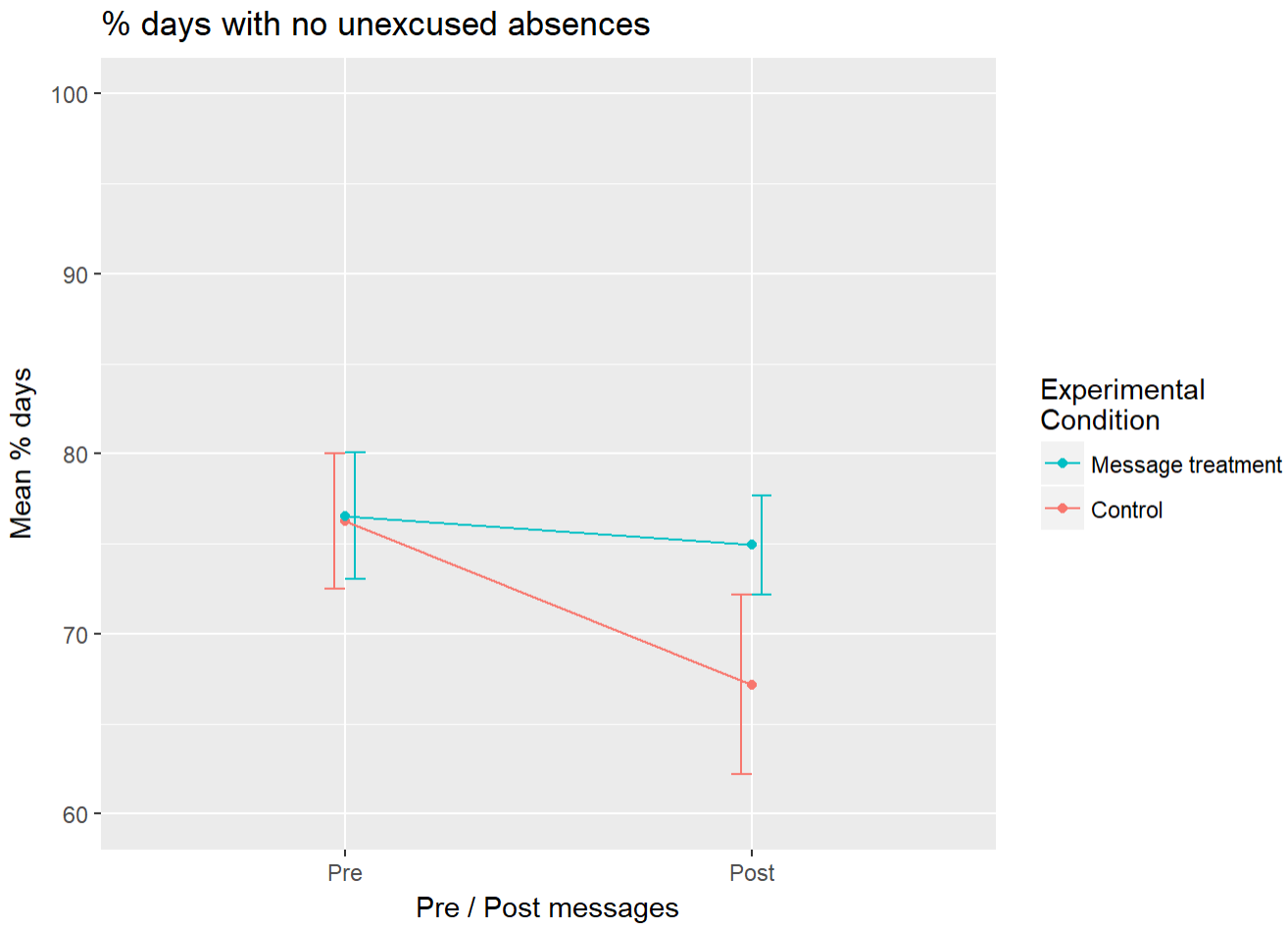

Figure 27: Study Two – Percentage of days with no unexcused absences - Combined treatment groups comparing all students receiving messages (GRPH+AUTMY and GRAPHICAL) with CONTROL

8.3.3.3 Classes missed: percentage of scheduled classes missed with unexcused absences

There was no significant difference between groups' absence rates when measuring the proportion of scheduled classes missed with an unexcused absence, $F(1,127)=0.59$, $p=0.4$. Cohen's d effect size was negligible. See Figure 28 and Table 36.

8.3 - Study Two: An early morning repeat evaluation of SMS-based autonomy supporting feedback intervention on school attendance rates - Results

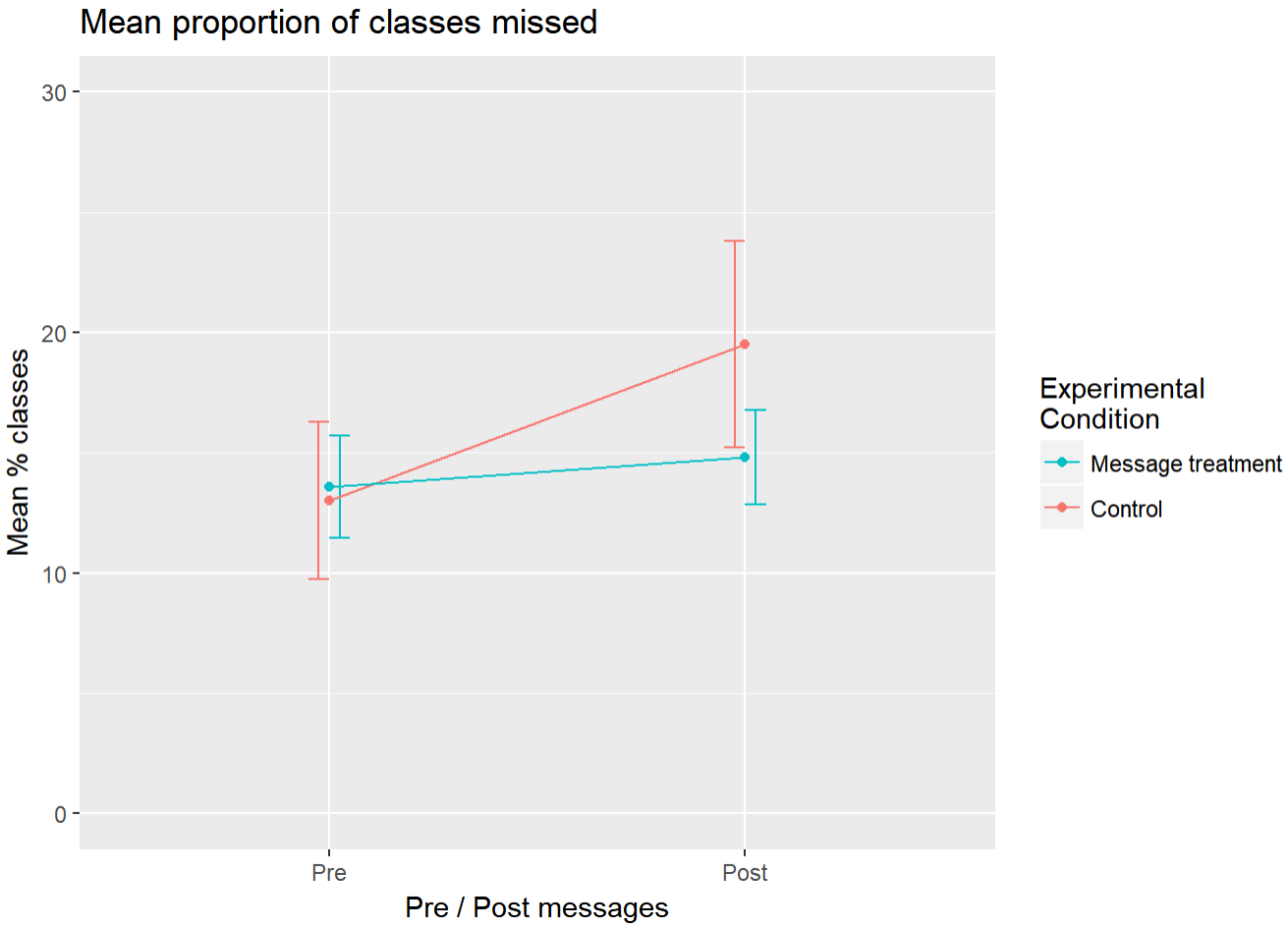

Figure 28: Study Two – Percentage of classes missed (unexcused) - Combined experimental groups comparing all students receiving messages (GRPH+AUTMY and GRAPHICAL) with CONTROL

8.3 - Study Two: An early morning repeat evaluation of SMS-based autonomy supporting feedback intervention on school attendance rates - Results

	Treatment		Control		ANOVA		
	Pre (N=46) Mean (sd)	**Post (N=52) Mean (sd)**	**Pre (N=21) Mean (sd)**	**Post (N=24) Mean (sd)**	**F(1,127) Group**	**F(1,127) PrePost**	Effect size (Cohen's d) (95% CI)
% days no unexcused absences	76.6 (22.3)	74.9 (18.8)	76.3 (17.1)	67.2 (23.9)	1.2	1.3	0.20 (-0.11 – 0.51)
% days unexcused all day	6.4 (8.9)	8.5 (10.3)	7.6 (15.3)	10.4 (20.5)	0.38	1.1	-0.11 (-0.42 – 0.19)
% of enrolled classes missed with unexcused absence	13.6 (13.4)	14.8 (13.4)	13.0 (15.0)	19.5 (20.6)	0.59	1.3	-0.14 (-0.45 – 0.16)

*** p<.05**

Table 36: Study Two – Mean attendance rates comparing all students receiving messages (GRPH+AUTMY and GRAPHICAL) with CONTROL

8.3.4 Hypothesis 2

Sending feedback together with autonomy supporting messages will increase attendance rates when compared with sending only feedback and with a no message control group.

There were no significant differences in absence rates among students receiving autonomy support messages together with feedback on attendance and those receiving only feedback. The results did not support the hypothesis.

8.3.4.1 All day absences: Percentage of days when absent all day (unexcused)

There was little difference between the percentage of days when students were absent all day (unexcused) after exposure to the messages: GRPH+AUTMY n=27, M=9.81%, sd=11.3; GRAPHICAL n=20, M=6.8%, sd=8.7; CONTROL n=23, M=10.4%, sd=20.5. Two-way ANOVA analysis found no significant difference between the groups, $F(2,125) = 0.41$, $p=0.7$. See Figure 29 and Table 37.

Cohen's d effect sizes were negligible when comparing GRPH+AUTMY and CONTROL (d=-0.35 CI: -0.61 – 0.54) and small when comparing GRAPHICAL and CONTROL (d=-0.22 CI: -0.84 – 0.40). Comparing the effectiveness of GRPH+AUTMY with that of GRAPHICAL found a small negative effect size (d=0.29, CI=-0.31 – 0.89).

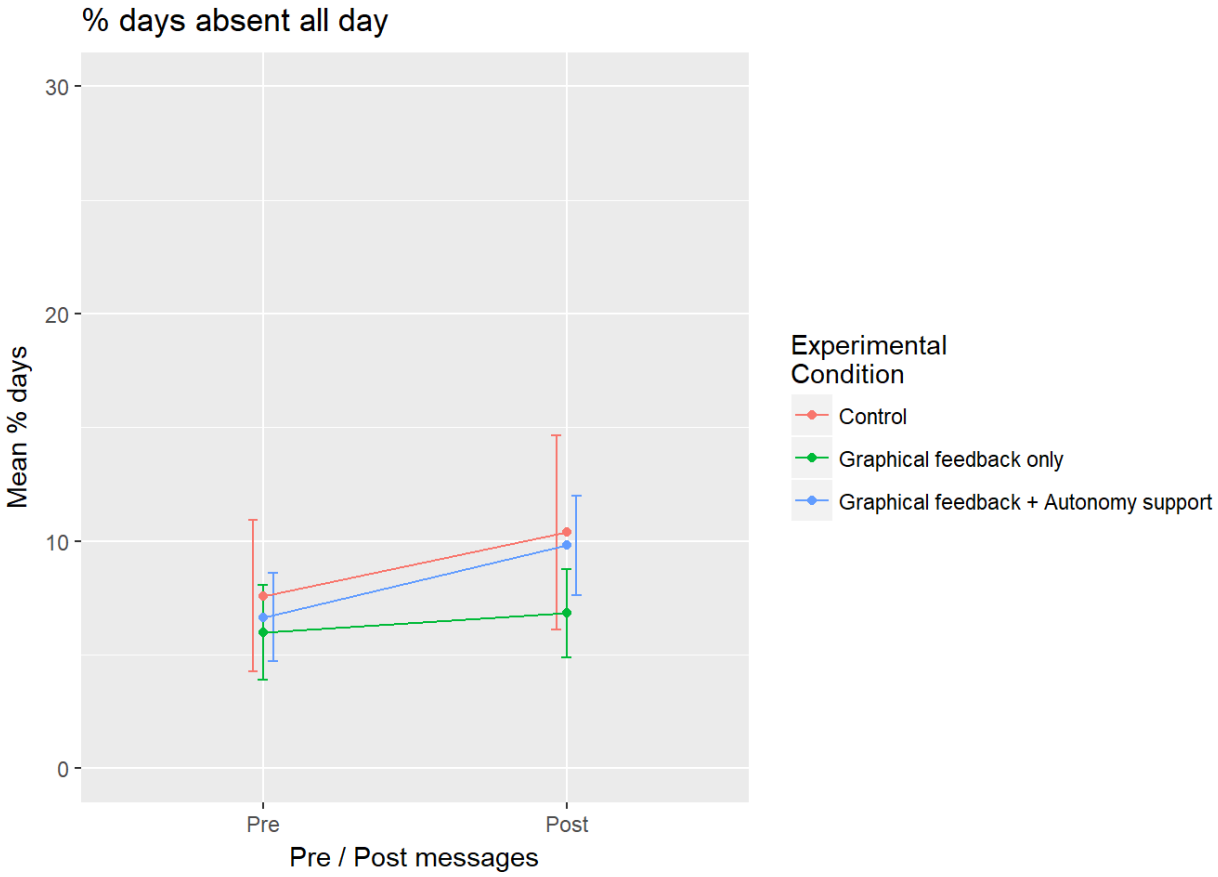

Figure 29: Study Two – Proportion of days absent all day comparing students in groups GRAPHICAL, GRPH+AUTMY and CONTROL

8.3.4.2 No absences: Percentage of days with no unexcused absences

Two way ANOVA analysis showed no significance difference between groups, F(2,125) = 1.05, p=0.4 when attendance is measured as days with no unexcused absences. Attendance rates in the control group (n=23, M=67.17%, sd=23.93) are a little lower than those in the the treatment groups GRPH+AUTMY: n=27, M=73.01%, sd=20.89 and GRAPHICAL: n=20, M=77.51%, sd=15.41). See Figure 30 and Table 37.

Cohen's d effect sizes were negligible when comparing GRPH+AUTMY and CONTROL (d=0.26 CI: -0.3 – 0.8) and small when comparing FB and CONTROL (d=0.51 CI: -0.12 – 1.1). Comparing the effectiveness of SDT with that of GRAPHICAL found a small negative effect size (d=-0.24, CI=-0.84 – 0.36).

8.3 - Study Two: An early morning repeat evaluation of SMS-based autonomy supporting feedback intervention on school attendance rates - Results

		Treatment						ANOVA		Effect size (Cohen's d) (95% CI)
		GRPH+AUTMY		GRAPHICAL		Control				
		Pre (N=23) Mean (sd)	Post (N=27) Mean (sd)	Pre (N=17) Mean (sd)	Post (N=20) Mean (sd)	Pre (N=21) Mean (sd)	Post (N=23) Mean (sd)	F(2,125) Group	F(2,125) PrePost	
Experiment Two	% days no unexcused absences	74.83 (25.74)	73.01 (20.89)	78.89 (17.00)	77.51 (15.41)	76.26 (17.13)	67.17 (23.93)	1.048	1.303	AUTMY/CON 0.26 (-0.31 – 0.83) FB/CON .51 (-0.12 – 1.1) AUTMY/FB -0.24 (-0.84 – 0.36)
	% days unexcused all day	6.650 (9.293)	9.808 (11.29)	5.978 (8.585)	6.834 (8.662)	7.581 (15.26)	10.38 (20.50)	0.414	1.069	AUTMY/CON -0.35 (-0.61 – 0.54) FB/CON -0.22 (-0.84 – 0.40) AUTMY/FB 0.29 (-0.31 – 0.89)
	% of enrolled classes missed with unexcused absence	14.08 (14.24)	16.53 (15.06)	12.90 (12.52)	12.51 (10.76)	13.01 (15.01)	19.50 (20.63)	0.6316	1.275	AUTMY/CON -0.17 (-0.74 – 0.40) FB/CON -0.42 (-1.0 – 0.21) AUTMY/FB 0.30 (-0.30 – 0.90)

* $p<.05$

Table 37: Study Two – Attendance Rates of All Participants comparing students in groups GRAPHICAL, GRPH+AUTMY and CONTROL

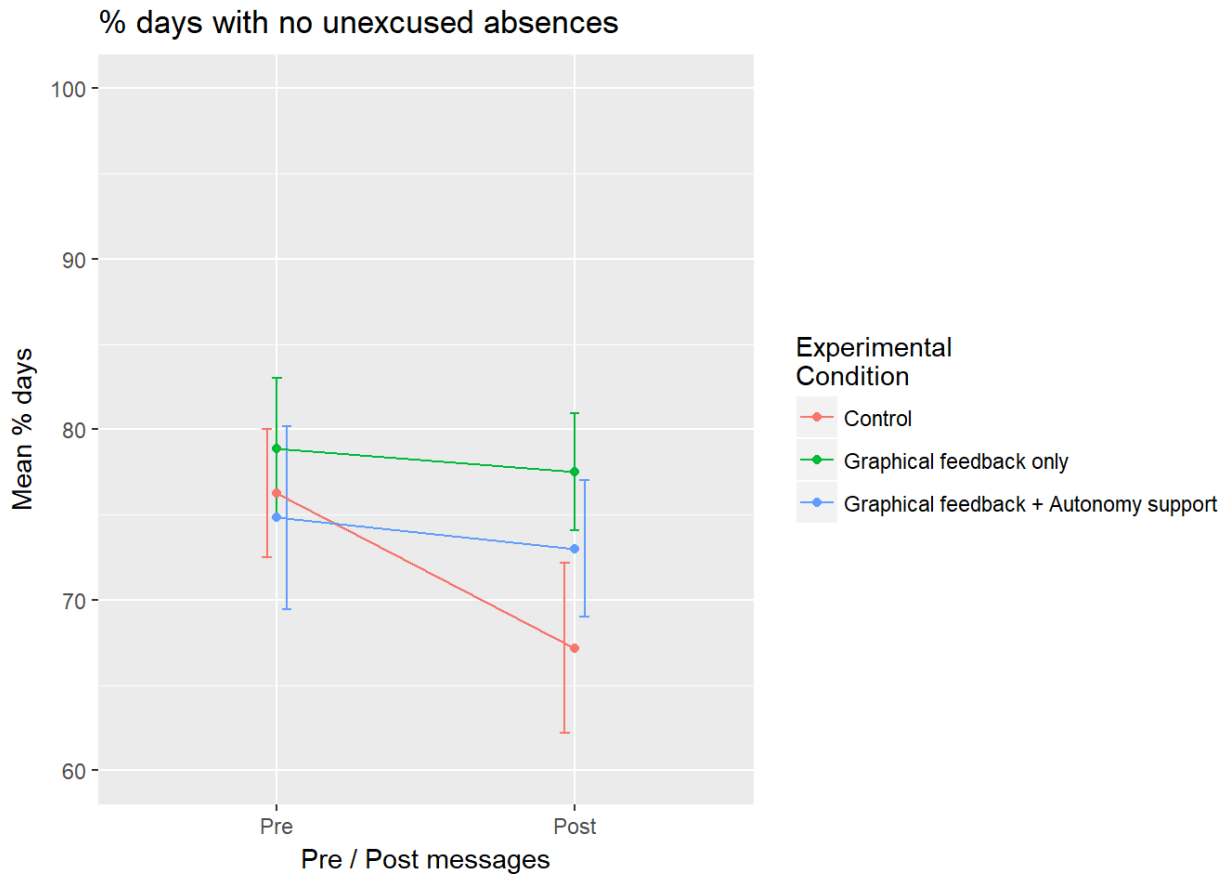

Figure 30: Study Two – Proportion of days with no unexcused absences comparing students in groups GRAPHICAL, GRPH+AUTMY and CONTROL

8.3.4.3 Classes missed: percentage of scheduled classes missed with unexcused absences

When number of classes for which a student was scheduled was compared to the number of classes in which they were present) there is a similar pattern with the lowest absence rate in the feedback only group (GRAPHICAL), n=20, M=12.5%, sd=10.8, and more classes missed in the control group (n=23, M=19.5%, sd=20.6) and GRPH+AUTMY: n=27, M=16.5%, sd=15.1. See Figure 31 and Table 37.

Two-way ANOVA analysis did not find a significant difference between the groups, F(2,125)=0.6, p=.5. Cohen's d effect sizes were negligible when comparing GRPH+AUTMY and CONTROL (d= -0.17 CI: -0.74– 0.40) and small when comparing GRAPHICAL and CONTROL (d=-0.42 CI: -1.0 – 0.21). Comparing the effectiveness of GRPH+AUTMY with that of GRAPHICAL found a small effect size (d= 0.30, CI= -0.30– 0.90).

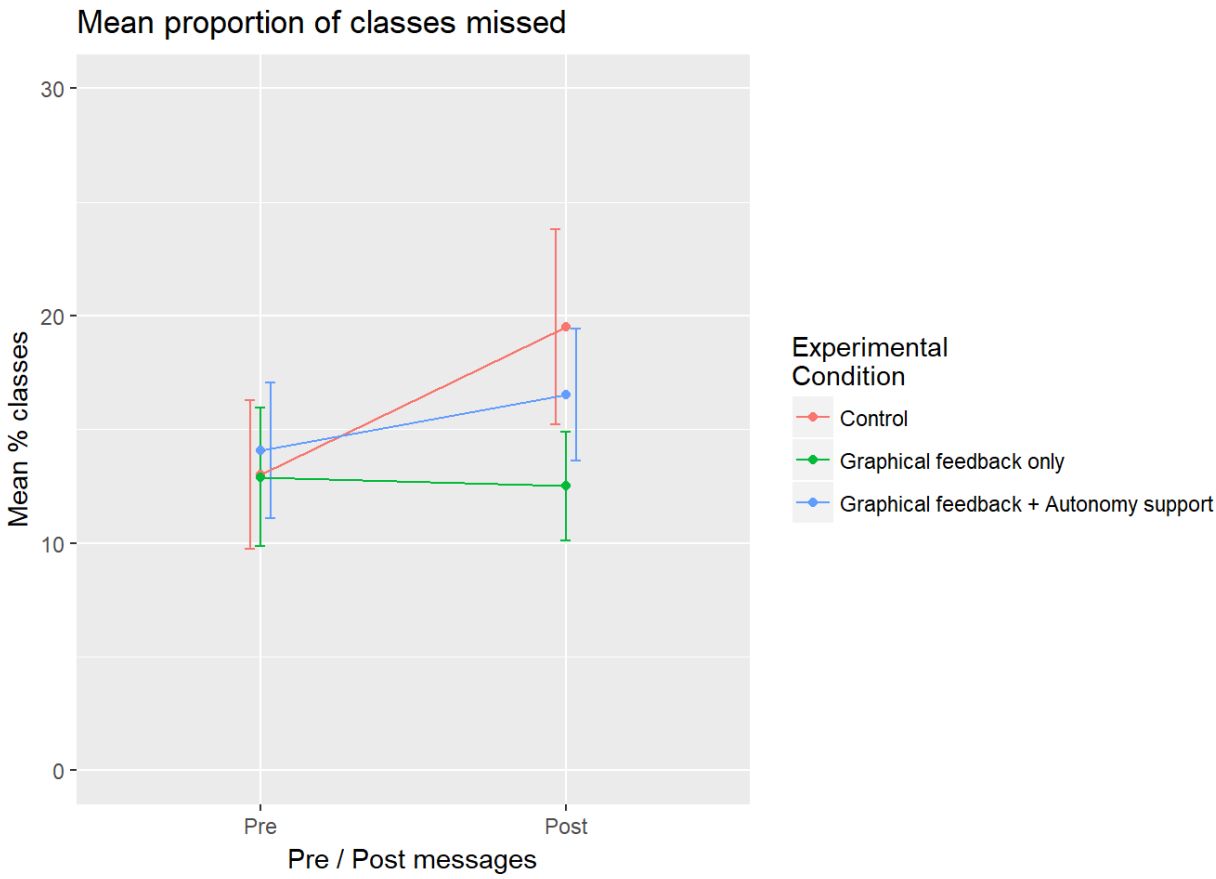

Figure 31: Study Two – Percentage of scheduled classes missed (unexcused) comparing students in groups GRAPHICAL, GRPH+AUTMY and CONTROL

8.3.5 Hypothesis 3

Sending autonomy supporting messages will increase perceived autonomy of recipients when compared to participants receiving messages without autonomy supporting components and with a no message control group.

Questionnaires similar to those used in Experiment One (see description of their development in section 7.2.1 and copies in appendix 11.8) were completed before and after messages were delivered. All students completed the pre-intervention questionnaires. 53 of 76 participants (70%) completed the post intervention questionnaires, others did not because they left school (either because they graduated or for other reasons) and were not available to complete them.

8.3 - Study Two: An early morning repeat evaluation of SMS-based autonomy supporting feedback intervention on school attendance rates - Results

There were no significant differences in perceived autonomy between the groups before sending the messages, F(2,67) = 1.41, p=0.3. After sending the messages, both groups receiving messages had higher perceived autonomy at school than the control group, F(2,50) = 3.72, p=0.03. See Table 38, The CONTROL group score was close to a "neutral" rating (n=14, M=4.24, sd=1.75) while the graphical feedback only, GRAPHICAL (n=15, M=2.72, sd=1.94) and those receiving additional autonomy supporting text, GRAPH+AUTMY (n=24, M=2.81, sd=1.56) scores were approximately half way between "strongly agree" and "neutral" on the questionnaire rating (see instrument in appendix 11.8).

		Before sending messages			**After sending messages**		
		CONTROL	**GRAPHICAL**	**GRAPH+ AUTMY**	**CONTROL**	**GRAPHICAL**	**GRAPH+ AUTMY**
	N	23	20	27	14	15	24
	Self esteem	5.04 (1.64)	5.55 (1.70)	5.44 (1.40)	4.71 (1.73)	5.64 (1.50)	5.04 (1.64)
		F(2,67) = 0.651, p=0.5			F(2,48) = 1.18, p=0.3		
	Truancy ladder	8.35 (1.70)	8.20 (2.02)	8.60 (1.72)	8.71 (1.59)	8.87 (1.41)	8.52 (1.88)
		F(2,67) = 0.288, p=0.8			F(2,49) = 0.197, p=0.8		
	Autonomy	2.87 (1.62)	2.83 (1.70)	3.59 (1.88)	**4.24 (1.75)**	**2.72 (1.94)**	**2.81 (1.56)**
		F(2,67) = 1.40, p=0.3			**F(2,50) = 3.72, p=0.03 ***		
Mood survey	**Anger**	0.93 (0.96)	0.59 (1.09)	0.89 (0.91)	0.810 (0.733)	0.733 (0.989)	1.06 (0.778)
		F(2,67) = 0.771, p=0.5			F(2,50) = 0.823, p=0.4		
	Confusion	0.46 (0.68)	0.50 (0.65)	0.54 (0.63)	0.226 (0.237)	0.750 (0.959)	0.632 (0.840)
		F(2,67) = 0.102, p=0.9			F(2,50) = 1.87, p=0.2		
	Depression	0.61 (0.72)	1.43 (1.08)	0.61 (0.96)	0.232 (0.332)	0.567 (1.08)	0.740 (0.974)
		F(2,67) = 0.2339, p=0.8			F(2,50) = 1.139, p=0.2		
	Fatigue	1.43 (1.08)	1.30 (0.73)	1.62 (1.06)	1.35 (0.948)	1.76 (1.23)	2.04 (1.25)
		F(2,67) = 0.631, p=0.5			F(2,50) = 1.56, p=0.2		
	Tension	0.85 (1.01)	0.40 (0.50)	0.57 (0.86)	0.750 (0.883)	0.850 (1.04)	0.920 (1.23)
		F(2,67) = 1.61, p=0.2			F(2,50) = 0.107, p=0.9		
	Vigour	1.99 (0.99)	1.83 (1.26)	1.78 (0.97)	1.93 (1.13)	1.60 (1.26)	1.68 (1.01)
		F(2,67) = 0.260, p=0.8			F(2,50) = 0.342, p=0.7		

Table 38: Study Two – Questionnaire data

8.3.6 Hypothesis 4

Sending messages at the time that students wake up to go to school will result in higher rates of attendance than those found in the first study where messages were sent at the end of the school day.

Sending the messages in the morning rather than at the end of the school day resulted in there being no significant effect on attendance in any group while Study One showed that the messages were effective in both groups when sent after school. The hypothesis was not confirmed.

8.3.7 Acceptability measure

Thirty-six participants completed the acceptability questionnaire: 12 from graphical feedback only group (GRAPHICAL) and 24 from the graphical feedback plus autonomy supporting text group (GRPH+AUTMY).

8.3.7.1 Quantitative analysis

No significant differences were found between groups in any of the measures. See Table 47 in Appendix 11.13.

8.3.7.2 Qualitative content analysis of free response items

The free text answers listed in Table 39 and Table 40 were analysed using a conventional contents analysis approach as described in section 7.2.4.4.

Answer to "Why?" free text question following "Do you think you attended school more or less often while you received the messages?"	
GRAPHICAL	**GRPH+AUTMY**
Because it kept me updated with my attendance	I feel like I attended school more because I became infatuated and school became more interesting - messages made me feel more on track about school
Helped me think more about weather how soon I would want to graduate	The days when I'm thinking of not going but then I get the message and decide to go
Because I know what classes and what days I 'm missing to show up excuse or just simply to get me on track	I don't know, I show up for school every day since I got in high school even before I got the messages
Because it shows me if I should miss a day or not	Because I have to work
Because	I really don't have time because I work
They push me to do better	Because I realized I was skipping too much
Because the text made me feel like my attendance is important	My nana works here so I can't miss
Like I could be laying down in bed just thinking if I should get up and the bang: I hear my phone go off and its that message of my attendance like an extra motivation	Because the messages let me know if I have perfect attendance or not
	Because it reminds you stuff every day
	So I could have proof that I went to school or not
	It made me feel bad when I didn't show up because it reminds you
	Because I still miss days
	Because it was mandatory to come
	because I shouldn't miss school

Table 39: Study Two – Answer to why do you think you attended school more or less often while you received the messages?

Answer to "Do you remember receiving any of the messages in particular? Why?"	
GRAPHICAL	**GRPH+AUTMY**
No my phone been off for a minute	Perfect attendance
Yes, so I can see my attendance	I remember it telling me I had 2 weeks perfect attendance
I'd be "shall I got to school;" and message can and I decided I should go	yes
Very annoying	I liked the quotes
Not really because they were mostly the same	I liked the ones that advice you to go to college every day
They tell me my attendance and absence of the month, day and week	It said I was absent when I wasn't
Yes, because it was like extra help to get up and ready	yeah when I missed a whole week it said something about the pay in between people who graduate and those who don't
	No
	Yes because my attendance was not that good
	Not in particular but the messages are good
	a couple Albert Einstein quotes
	No I don't
	No I do not
	Yes because I get them every morning
	yes, one day it told me I was marked absent and I went to get it fixed
	No and because I really didn't pay no mind

Table 40: Study Two – Answers to Do you remember any of the messages in particular?

8.3.7.2.1 Question: Do you think you attended school more or less often while you received the messages? Why?

Examination of the responses suggested themes of reminding/tracking, changing their mind, having no effect because they already attended regularly, empowerment, and the importance of regular attendance.

Reminding/Tracking

This was the most common theme of response and was spread evenly across both groups. For example, "Because it kept me updated with my attendance", "Because it reminds you stuff every day". As

in Experiment One, some participants suggested that they would not have known how often they attended were it not for the messages: “Because I know what classes and what days I’m missing to show up excused r just simply get me on track” and “Because I realized I was skipping too much”. Another suggested that they inspired goal setting: “they push me to do better”.

Changing their mind

Two participants in the GRPH+AUTMY group said that they messages changed their mind and convinced them to come to school on days when they would otherwise have stayed home: “The days when I’m thinking of not going but the I get the message and decide to go” and “Like I could be laying down in bed just thinking if I should get up and then bang: I hear my phone go off and it’s that message of my attendance like an extra motivation”.

Already attending regularly

Two participants in the GRPH+AUTMY group said that they already attended most days.

Empowerment

One student in the GRPH+AUTMY group said that the messages gave them “proof that I went to school or not”. Two others said that they did not have control over when they came to school because “I have to work” and “I really don’t have time because I work”.

The importance of attendance

Three students answered that they needed to attend school regularly.

8.3.7.2.2 Do you remember receiving any of the messages in particular? Why?

No

This was the most common response, with additional comments like “No and because I really didn’t pay no mind” from a student in the GRPH+AUTMY group or “No because they were mostly the same” from a student in the GRAPHICAL group. One student in the GRAPHICAL group commented that they were “very annoying”.

Specific memories

Three participants in the GRPH+AUTMY group had specific memories of the messages: "I remember it telling me I had 2 weeks perfect attendance", "Perfect attendance" and "Yeah when I missed a whole week it said something about the pay in between people who graduate and those who don't". The last answer was from the student who answered previously that they had to work and that was why the intervention had not change their attendance.

In the GRPH+AUTMY group, the quotations were noted as memorable by several students: "I like the quotes", "I liked the one that advice you to go to college every day", "Not in particular bu the messages are good", "a couple Albert Einstein quotes", and "Yeah when I missed a whole week it said something about the pay in between people who graduate and those who don't".

Empowerment

One student in GRPH+AUTMY group had their attendance corrected after they were incorrectly marked absent, another just remembered that it was incorrect.

Extra help

One student from each group remembered the messages helping them choose to go to school: "I'd be 'shall I go to school?' and the message came and I decided I should go" and "Yes, because it was like extra help to get up and ready".

8.3.7.2.3 Comparison with findings in Study One

In both studies, the most common comments referred to the benefits of being able to keep track of their attendance. Comments were also made around the topic of empowerment in both studies, though in the second, two participants stated that their ability to attend was limited by their need to go to work. The feedback messages were sent on the following morning in the second study in order to 'trigger' attendance behaviour and several students claimed that the messages had done just that.

8.4 Summary of findings

The goal of this study was to further investigate the difference in effect that adding autonomy supporting text to graphical performance feedback had on participant attendance. The methodology of this study was very similar to that of the first (described in chapter 7) but set out to answer a further research question: would sending feedback on the following morning rather than immediately after school further improve attendance? The theoretical basis of this decision was the Fogg Behaviour Model (Fogg 2009) which posits that messages act as triggers and should be delivered at the time that a choice is being made. In this case, they were sent at the time that participants woke up on the assumption that that was the time that they chose whether to attend school or not.

In this study, the messages had no significant effect on participant attendance in any of the measures taken (section 8.3.3 and 8.3.4) which suggests that timing may be an important component in intervention design. Trends similar to those in Study One were seen in measures of days with no absences and the proportion of classes missed with participants receiving feedback + autonomy supporting text attending more often than both the feedback only and control groups. However, the trends were not seen in full day absences where the effect had been strongest in the first study. As no direct, controlled comparison between morning and evening messages was undertaken, some other variable may also be the cause such as the time of year. Nevertheless, this study offers an interesting data point which is discussed further in chapter 9 suggesting that delayed feedback is less effective than feedback closely following the time of behaviour.

A significant difference is found in the measures of perceived autonomy in school with both groups that received messages scoring significantly higher in perceived autonomy than the control group (section 8.3.5). This was not the case in the first study and may be a type 2 error or it may be that making the measures available in Spanish allowed for more accurate measurement (section 7.3.5) and that both message types support autonomy. If that is the case, the finding suggests that the feedback delivered in

graphical format was also autonomy supporting which would account for the similar effectiveness of the intervention conditions seen in the first study.

As in the first study, no significant differences in acceptability were found and participant reactions were generally very positive (section 8.3.6) although two participants in this study sent STOP messages to block receipt of messages from the intervention while none did so in the first study.

9 Discussion and Conclusions

9.1 Introduction

School absenteeism is a problem affecting children around the world with deleterious effect to their education (Chang and Romero 2008, Moonie et al. 2008, Balfanz et al. 2007) and long-term outcomes (Ahmad and Miller 2015). Performance monitoring and counselling can help children who are chronically absent to attend more regularly but delivery of such interventions requires trained personnel and small group or individual counselling and is resource intensive (Bynum et al. 2004, Cabus and De Witte 2015, Herrick 1992, Flanagan 2006, Tichenor 1991, Licht et al. 1991, Fantuzzo et al. 2005). Digital communications technologies have the potential to provide low cost, highly scalable interventions. This research examined the effectiveness of an intervention that provided daily feedback to students in the form of a graphical device similar to a scoreboard in a video game that was sent directly to the student's cell phone as an SMS message. The effect of additional autonomy supporting text was investigated as a result of findings in the pilot study and previous research described in the literature review that suggested that Self Determination Theory and students' perceptions of autonomy in school contribute to their decision as to whether or not to attend regularly. To study the effect of feedback timing on attendance, the intervention was evaluated in the first study with feedback delivered at the end of the school day and in the second with the messages sent on the following morning when students awoke. This differing timing of feedback tested the hypothesis based on the Fogg Behaviour Model (Fogg 2009) that messages should be sent to "trigger" behaviour at the time of action.

9.2 Research questions

The overarching research questions asked at the start of this thesis (section **Error! Reference source not found.**) were:

RQ1 – Can feedback delivered by SMS change school attendance behaviour?

RQ2 – Which elements of the feedback predict effectiveness: for example: message content, tone, timing, format?

9.3 Discussion

The findings show that graphical feedback alone was sufficient to have an effect on school attendance behaviour. The first study supported our hypothesis that sending graphical feedback to students about their attendance reduced absenteeism when sent at the end of the school day. The addition of autonomy supporting messages to the graphical feedback was not found to have a significant effect on attendance (chapter 7). Attendance rates of participants receiving both types of message were significantly higher than those of participants in the control group who received no messages. In the second study, when messages were sent on the following morning, there was no significant difference in student attendance between those receiving the interventions and those in the control group and the hypotheses were not confirmed. (chapter 8).

In the first study when messages were sent immediately after school, effect sizes were comparable to the average effect size (0.46) reported in the systematic review of attendance interventions by Maynard et al (2013). That review encompassed group counselling, court interventions and positive behaviour interventions that required substantially more resources in terms of staff time and could only address relatively small numbers of participants. Often these were operationalised through tracking their attendance with signatures from teachers (Brooks 1975, Flanagan 2006) or sticker charts (Zweig et al. 1979, Ford, Janet and Sutphen 1996) and offering prizes in especially scheduled classes. Recent studies have found sending summaries of recent attendance data and school performance to parents by mail and text message can increase attendance rates on a larger scale (Rogers and Feller 2018, Bergman and Chan 2017).

The second study investigated whether sending the messages at the time that participants woke up for school would increase the effect on days with no unexcused absences, as morning classes had been found to be most often missed in the first study. In order to activate the “trigger” mechanism described by

Fogg (2009), messages were scheduled to be delivered at the time that the participants woke to go to school. The study did not support the hypothesis that "triggering" a decision to attend school at the time that participants woke in the morning would improve effectiveness of the intervention. Instead, the intervention was found to be ineffective with similar levels of absenteeism in both groups receiving the intervention and the control group. Delaying the feedback rather than delivering it immediately after the school day appears to support the behaviourist literature surrounding feedback in educational settings and the understanding that feedback is most effective if given sufficiently close to the locus of behaviour for recipients to connect the two (Ilgen et al. 1979, Skinner 1953).

The results also support the Feedback Intervention Theory (Kluger and DeNisi 1996) which posits that feedback leads to behaviour change as a result of shifting a person's attention from general, moderate and easy performance/standard comparisons to the particular performance/standard gap that the intervention is targeting. This is similar to the notion of "tunnelling" described by Mullainathan and Shafir (2013) which describes how individuals under the stress of poverty focus on immediate needs and problems rather than taking a more holistic view. Text messages are often a component in "nudging" interventions (Thaler and Sunstein 2009), bringing topics that may be forgotten in the maelstrom of life back into one's sphere of active engagement. Several participants indicated in the acceptability questionnaire that they appreciated the information contained in the messages because they would not otherwise know how much school they were missing (see sections 7.3.6.2 and 8.3.7.2). Rogers and Feller (2018) similarly found that parents underestimated their child's absenteeism.

It was hypothesized that the addition of carefully constructed autonomy supporting text to the simple graphical feedback would increase participants' perceived autonomy at school and in turn, reduce their absenteeism. However, the addition of autonomy supporting text had no effect on students' absence rate. While it may be that perceived autonomy does not correlate with student attendance, the opposite has been reported (Vallerand et al. 1997). Alternatively, it may be that the graphical feedback in its simple, non-judgmental and neutral format is itself, autonomy supporting. In a review of feedback delivery in

clinical settings through the lens of Self Determination Theory, Ten Cate (2013) recommended simple video recordings of medical trainees' performance without verbal criticism so that trainees are left to draw their own conclusions with their autonomy preserved. That providing feedback without commentary protects the recipients' perceived autonomy may explain why both experimental groups showed such similar effects but this is not borne out by the measures of perceived autonomy in school which showed no difference between experimental groups.

A significant difference in perceived autonomy in school was found in the second study (section 8.3.5) but not the first (section 7.3.5). This may be a type 2 error or may be a result of offering the questionnaire in both English and Spanish in the second study and increasing the accuracy of the measure. Because both quantitative and qualitative analyses of the acceptability measures from study one and study two suggest a very similar reaction to the interventions, it is likely that the interventions had similarly positive effects on perceived autonomy and this finding is the result of improved measurement. Analysis of the graphical feedback device through the lens of Self Determination Theory would suggest that the graphic provides for the need for mastery by conveying performance and for autonomy by not colouring that performance feedback with extrinsic value judgments. However, the hypothesised connection between perceived autonomy and attendance was not demonstrated.

The graphical feedback alone or combined with autonomy supporting messages had no impact on measures of participants' mood, self-esteem or stage of change. Because the sample was drawn from a specialized population, the results of the secondary measures regarding stage of change were not unexpected. As all participants were enrolled in an alternative high school specializing in dropout recovery and classified as already being at high risk of dropout, it is not surprising to find that they had decided to try to attend regularly. If they had not, they would most likely not be enrolled. Absenteeism was measured in terms of full day absences and days with no absences because it is often unclear in previous literature just what measures are being used and because these are very different goals. In the first, we measure if participants come to school at all during the day, but the bar is set higher in the

second, only counting them as attending if they attend each of their scheduled classes. As can be seen in the Message Rules Matrix (Appendix 11.4), messages were written to praise participants when they came to school for even part of a day. Therefore, finding that the effect on days with no unexcused absences was less than for all day absenteeism matches the expectations of the intervention design.

The results of the moderation and post hoc analyses of the first study showed that the effect of the messages varied among different sub-populations within the sample. This is consistent with both SMS interventions and attendance interventions which have previously been found to have different effects in different sub-populations (Reid and Bailey-Dempsey 1995, Filion et al. 2015, Guillory et al. 2015). Maynard et al (2013) commented in their review that demographic descriptions were often missing from intervention reports (only 10 out of 28 studies included race and ethnicity while only 4 reported socio-economic status of participants). As a result, while demographic characteristics were generally known to correlate with absenteeism (also described in section 2.5), they were unable to conduct any moderation analyses to investigate the interaction of student characteristics with intervention effectiveness.

In the studies described in this thesis, demographic data were available and post-hoc analysis showed that the intervention was especially effective among participants whose main home language was Spanish. It should be noted that the majority of these participants (70.2%) opted to receive message in English rather than in Spanish (see section 7.3.8.4.5). That the preferred language of most these participants was different than their "home language" suggests that the label "home language" characterises a function of their home life rather than an individual factor. Participants receiving the messages missed approximately 5% full days of their enrolment while those in the control group missed approximately 22% (more than a four-fold reduction in absence). While there was no significant difference between the intervention groups in terms of absenteeism, participants receiving only the graphical feedback were found to have a more negative mood (more angry, depressed and fatigued) than those receiving the additional autonomy supporting text. They also scored lower on the enjoyment scale in the acceptability survey. Steinberg et al (1984) found that language minority Hispanic students were

more likely to drop out than language minority children of other racial backgrounds even when controlling for socio-economic status. Hernandez (2007) found that for students from homes where Spanish was the main language, it was three times as likely to have both parents with less than a high school education than if English was spoken. It may be that this intervention fills a gap for students from families with little experience of the education system.

Our findings of more negative mood and lower enjoyment among participants receiving only the graphical feedback with a home language of Spanish may support findings by Kraft and Rogers (2015). They found that while sending messages about missed assignments and absence to parents improved student attendance and school success, participants' perceptions of their own performance was reduced and their relationships with teachers were poorer. It may be that the autonomy supporting text component of the messages softened feelings of failure and messages of praise celebrated success; some of the free text comments in the acceptability measures would support this. For example: "It was always good to receive something encouraging", "I remember it telling me I had 2 weeks perfect attendance".

9.4 Contributions

9.4.1 Contributions to theory

9.4.1.1 Autonomy support and Self Determination Theory

This study evaluated two intervention groups, one receiving simple graphical feedback displaying their recent attendance without commentary and the other receiving additional tailored text based on Self Determination Theory (SDT). There are few studies evaluating theoretical bases of SDT in text messaging interventions. Kinnafick et al (2016) compared an SDT based intervention with a no treatment control group and found that the intervention increased physical exercise but without a second intervention group, was not able to examine the importance of the SDT components. Thompson et al (2016, 2014) have undertaken a feasibility study comparing SDT based intervention with a no treatment control and additional intervention groups but have not yet published results of a full study. This thesis research was based on an additive design to isolate the effect of the SDT-grounded autonomy supporting

text messages and found no significant effect on attendance rate beyond the effect of simple graphical feedback.

9.4.1.2 Timing of feedback

While characteristics of computer driven feedback has been studied extensively in the context of educational interventions (Shute 2008), its characteristics in behaviour change interventions are much less well understood (Larson et al. 2013). While the effect of message frequency has been investigated (Augustson et al. 2017, Pop-Eleches et al. 2011) little similar work has been undertaken to investigate the timing of feedback messages in computer driven behaviour change interventions. This research describes a repeated intervention evaluation undertaken in the same environment changing only the timing of the feedback and finds a substantial difference in effect which suggest that timing of feedback is important This echoes suggestions by Riley et al (2011) that computer driven behaviour change interventions may be more complex than current theoretical models of behaviour change can represent because of their dynamic and adaptive nature. The findings in this thesis support the delivery of feedback closely following the behaviour rather than delaying feedback until the next time at which the behaviour should be triggered.

9.4.1.3 Truancy Ladder

This research includes the development of an instrument for measuring stage of change in the context of school attendance that includes a thorough description of its connections to previous works. Previously published measures of stage of change include measures of stage of change in marijuana use among adolescents (Slavet et al. 2006), smoking cessation (Biener and Abrams 1991) and general health improvement (Zimmerman 2000). As noted above, no differences were found between pre and post interventions measures of stage of change but this was not really surprising because there was a sample bias towards the later stages of change. Participants were recruited from a population of students who were either about to drop out of school or had already done so and had returned to school in order to

graduate. As such, most had already reach an 'action' stage in the stage of change continuum (see section 3.2.3)

9.4.2 Contributions to practice

This research describes the implementation of a school attendance intervention based on performance monitoring together with data from a randomised controlled trial that indicates its effectiveness. The current literature includes few such studies (Hess 1990, Licht et al. 1991, Brooks 1975, Rogers and Feller 2018, Bergman and Chan 2017). School absenteeism is a widespread problem: three million (18%) high school students in the USA missed more than 15 days of school in 2013-14 school year (US Department of Education and Office for Civil Rights 2016). In England 10.5% of students were classed as "persistent absentees" having missed more than 10% of possible sessions in 2015/16 (Department for Education 2017). The intervention evaluated in this study was found, in the first study, to reduce full day absenteeism by half (from 16% in the control group to 7.8% among participants receiving one of the interventions) and increase days with no absences by 10% (from 71% in the control group to 81% among participants' receiving one of the interventions) (see section 7.3.3).

The low cost of scaling this intervention is especially compelling. The hosting costs were less than $25/month and the messages cost just $0.02 each. Over the course of a full school year (approximately 180 days), the marginal cost per student would be $3.60. The intervention described in this research could easily scale to support thousands of students at once.

Given that the messages reduced the number of days that participants were absent without a valid excuse by a half, the benefits to participants and schools are substantial. In Texas for example, school funding is cut by as much as $45 per day per student that is absent (AISD 2015). Administration of the intervention was minimal and could be automated. In the case of these trials, student schedule and attendance files were generated on the school computer systems each day and then loaded into the application by the researcher. This step could be automated through the use of data integration products.

This platform for delivering attendance support offers a new research tool to address behaviour change. The close linking of messaging software to reliable and highly granular attendance records enables delivery of individually tailored messages, on an automated and personalised schedule for each student at low cost. This is a far cry from sticker charts and weekly meetings. A future dimension of the intervention could include enabling students to respond to messages, perhaps to submit documentation for absences or to request help from attendance officers or to start building the relationships with school administrators that at-risk students need for success.

9.5 Study limitations and strengths

There are a number of limitations to the study that need to be considered. First, the generalisability of the findings may be limited because of the unusual population from which the sample was taken. As described above however (section 7.3.8.3), though the stratified analysis of the first study shows that the intervention was not most effective with the most extreme cases in the school but rather with those participants close to the median attendance rate prior to the intervention.

A further limitation to the results gathered from the questionnaires was the number of participants (30%) failing to complete the final questionnaires. However, this may be normal among this population. In a similar study, Bergman (2015) found that over one third of parents to whom notifications of missing assignments had been sent by email, SMS and telephone did not complete the final questionnaires. It should be noted that 100% of attendance data was collected for each student for each day that they were enrolled at the school and only the secondary measures suffered from missing data. Full completion of the questionnaires may have led to further findings in the analysis of the mediating effects of mood, self-esteem, stage of change and perceived autonomy.

That both styles of messages changed behaviour in the first study raises the question of a confounding effect which could have been controlled through a fourth group receiving an attention matched control intervention, for example messages about music with no references to school attendance.

However, in the setting of this study it was not possible to recruit sufficient numbers participants for this second control group.

Previous studies of text message interventions and attendance interventions often lack a theoretical foundation. A strength of the intervention evaluated in this thesis is that it was based in theory, primary research and secondary research as described in chapters 2 to 6. Another strength of this study is that unlike other attendance intervention reports, this study does not assume that participants are enrolled throughout the study period. Instead, the attendance statistics in this study take into account the number of days that each student was enrolled in the school. Unlike many of the SMS behaviour change studies in the literature, this study does not rely on self-reported adherence or secondary measures of behaviour such as prescription refills. Instead it uses objective records of behaviour recorded contemporaneously by teachers as part of their regular duties.

The baseline data in both experiments shows that all groups were broadly equivalent and attendance data collected before messages were sent shows no significant difference in attendance between the groups. While absences increased generally in all groups between the pre and post intervention measures, random selection into groups combined with evidence of the equivalent attendance rates earlier in the year make the objective measures showing a difference between groups after the intervention particularly strong.

This research describes two randomised controlled trials of an attendance intervention with an accurate and objective outcome measure, being the class by class school attendance recorded by teachers and checked by the attendance clerk. There are few randomised controlled trials of attendance interventions and most of these have interventions delivered by teachers or school staff (Hess 1990, Hess et al. 1990, Herrick 1992, Tichenor 1991) rather than with the fidelity enabled by an automated computer based system as in this study. Furthermore, because attendance measures are routine in participants' school experience, there is no risk of a measurement effect in this study. The primary measures in this study also avoided the risk of inaccurate self-reporting that have been seen in other text messaging

intervention evaluations and described in sections 4.2 and 4.3 (Boker et al. 2012, Rodgers et al. 2005, Free et al. 2011).

9.6 Future work

The finding that the intervention was most effective with participants from homes where Spanish is the primary language suggests either a characteristic of those homes that the intervention compliments or something missing in those homes that it provides to encourage school attendance. Further investigation of these participants' home life situations would be interesting as there appears to be some component of their lives that makes the receipt of feedback on attendance particularly beneficial and the addition of autonomy supporting text uplifting. This group is known to be in most need of support (section 2.4) and this type of intervention appears to be able to help at low cost and high potential scalability.

The finding that changing the timing of the feedback substantially changed the effectiveness of the intervention is an interesting first marker in the understanding of feedback characteristics in behaviour change interventions delivered by text message. A further study directly comparing immediate and delayed feedback and including further qualitative research into participants' perceptions of the intervention would contribute to the sparse literature surrounding the timing of feedback in behaviour change interventions.

This study was undertaken in an unusual population, possibly of the most challenging students with respect to school attendance but in a school environment focussed specifically on supporting school attendance. While the random assignment of groups controlled for any effects that the school environment may have had, an evaluation of the intervention in a more typical school population would make the result more generalisable for implementation in more standard school settings.

9.7 Summary

This thesis involved drawing on theories of behaviour change, the extant literature on addressing school absenteeism and prior evaluations of text message behaviour change interventions (albeit mainly in the health behaviour field) to design an intervention delivered by text message to support school attendance in students at high risk of dropping out of school. It was found that the rate of absenteeism could be reduced by as much as a half through the delivery of automated, individualised text messages that included graphical feedback of recent attendance performance.

The research in this study has shown that simple graphical feedback on performance is sufficient to change complex behaviour like school attendance among habitually truant students and that it can be effective when delivered electronically, likely at a much lower cost than traditional interventions delivered by teachers and school staff. While the addition of autonomy supporting messages may have made the intervention more palatable to some participants, it was not found to have a significant effect on attendance for all students. However, the timing of the messages appears to be crucial; feedback that was delivered immediately after the school day was found to be effective but ineffective when delayed until the following morning.

The findings suggest that properly applied, graphical feedback-based behaviour supports can be delivered by SMS to effect substantial behaviour change in this context. Many students were supported at much lower cost than traditional means to decrease absenteeism from school. Future research should focus on testing other theoretical determinants of school absenteeism and feedback timing to develop science-based behaviour change interventions in this field.

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11 Appendices

11.1 Ethical approval

11.1.1 Pilot Study

Certificate of Ethical Approval

Applicant:

Walter Burrough

Project Title:

Attendance coach

This is to certify that the above named applicant has completed the Coventry University Ethical Approval process and their project has been confirmed and approved as Medium Risk

Date of approval:

17 August 2015

Project Reference Number:

P36019

11.1.2 Study One and Two

Certificate of Ethical Approval

Applicant:

Walter Burrough

Project Title:

ShowUp4Success - supporting students' school attendance with autonomy supporting short messages

This is to certify that the above named applicant has completed the Coventry University Ethical Approval process and their project has been confirmed and approved as Medium Risk

Date of approval:

13 March 2016

Project Reference Number:

P42261

11.2 Technical implementation

11.2.1 Pilot trial

Figure 32 shows the object model for the application and one can see that the central object in the application are the Student, Absent Periods and Messages objects.

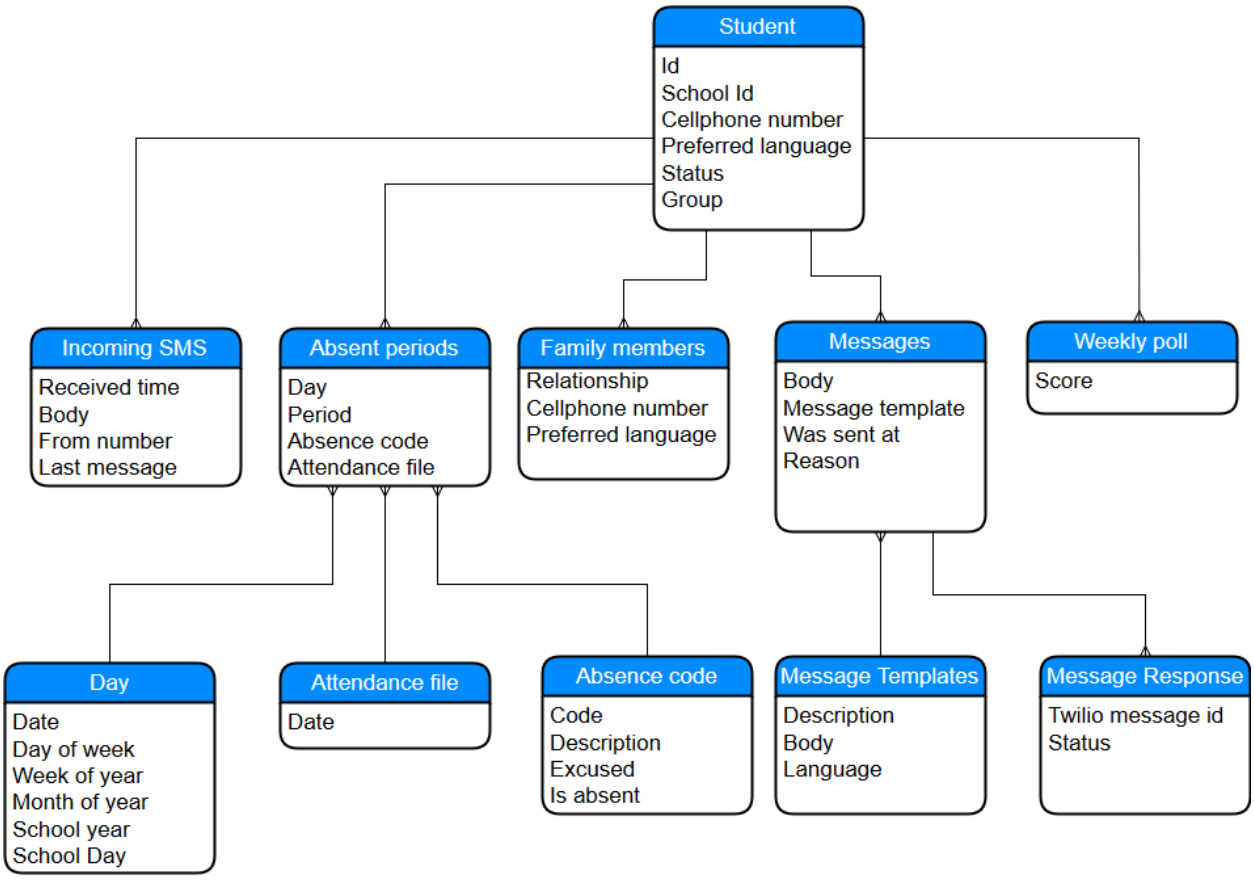


Figure 32: Pilot application object model

11.2.1.1 Sending messages

Message templates were drafted and saved in the database. Each was labelled with a Description which was used by the application as an index in the message sending algorithm. Where multiple templates were drafted for a particular index, a version was chosen at random to introduce variety.

Multiple versions of every message template were saved in the data table in different languages as specified by the Language column. In this study, messages were saved in just two languages (English and Spanish) but any number of languages would be possible.

At the end of each school day, an algorithm inspected the attendance record of each student and created messages as specified in a series of rules (see Appendix 11.4) and their Preferred Language (as ascertained upon registering in the trial) which were immediately sent using the Twilio messaging service.

Messages to family members were created and sent in the same way. The messaging service logged confirmations of sending the message, delivery errors where appropriate and of delivery to recipients' devices, though the latter was not available for some cell phone networks. Logging was achieved through "web-hooks", webpages made for access by the Twilio web service rather than for people. In the case of delivery errors, the errors were addressed and the messages resent.

11.2.1.2 Enrolment

As detailed in section 2.6.5, the literature describing attendance interventions is not generally clear on how attendance rates are calculated and do not appear to generally take into account the number scheduled classes or the period for which students are enrolled. Because student enrolment is not always consistent, the application was designed to allow for enrolment and withdrawal to take place at any time, to allow re-enrolment where necessary and to still calculate the correct attendance rate. An Enrolments table recorded enrolment events and withdrawal events and was used to determine whether or not a student was enrolled on a particular day.

Because of the special nature of the school, it was also necessary to account for students who attended only part of the day, either because they had a job or because they had nearly completed the classes necessary for graduation. An Enrolled Periods value recorded the number of classes for which a

student was enrolled at any time and was updated by the researcher and school office staff as their schedule changed.

11.2.1.3 Absent Periods

At the end of each school day a file was downloaded from the school attendance system. It consisted of rows labelled for each student on multiple dates. Seven columns contained codes related to student attendance. These described events such as unexcused absences, excused absences for various reasons, corrections by the attendance clerk to record students as present who had been recorded as absent by their teachers or as in disciplinary placements on another campus. Where no code was recorded for a student on a particular class period it signified that they were present.

The file was uploaded to our application by the researcher and the application read the file, recording any codes listed in the Absent Periods table which was linked to the Absence Codes table which classified each code as Present or Not Present and where not present, Excused or Unexcused.

Because messages were tailored not only to attendance behaviour on the day of the message but to recent attendance, it was important to account for weekends, holidays and occasional days when students were not required to attend. This was done using a calendar table[7] called Day to which all absent periods were linked (rather than recording their date). The calendar table detailed whether the day was a school day or not and also classified each day with a day of the week, month of the year and year label which simplified database queries.

11.2.1.4 Message responses

The Twilio service can accept incoming SMS messages and forward their contents (the originating cell phone number and the message body) to a web-hook as a HTTP Post request. Our

[7] https://www.sqlshack.com/designing-a-calendar-table/

application examined each incoming message and if the originating number was not on record for any student, an error message was sent. Where the body consisted of only a number, it was recorded as the score of a Weekly Poll and otherwise the content was forwarded to the researchers by email. Participants sending a message to the application received a reply stating that their message had been received by a computer and if they needed any help they should call the school office on the number included in the message.

11.2.2 Studies One and Two

As noted in section 6.5, the family member and weekly poll were removed from the intervention. The following additions were made.

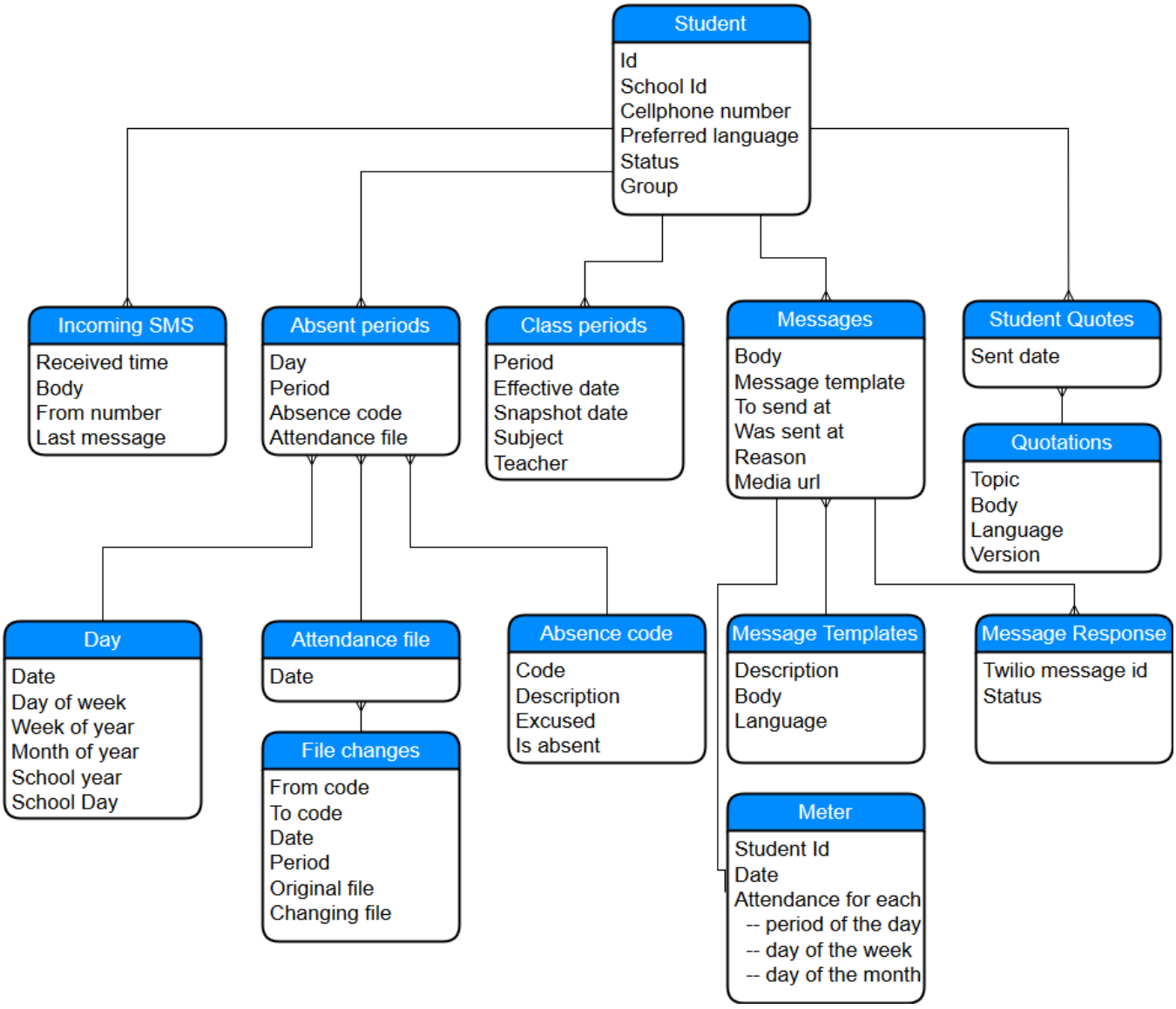


Figure 33: Evaluation application model

11.2.2.1 Attendance meter

The attendance meter is a graphical representation of recent attendance, described in section 6.5.2. It was generated dynamically by the Ruby application using the ChunkyPNG gem[8]. Twilio sends

graphical messages when a text message is submitted to their web service together with a URL for a valid graphical file. In our first trial of this intervention we submitted a URL to a web-hook that generated the image file dynamically. Generating the image took several seconds and when sending multiple messages, the server could easily be overwhelmed by requests for the image and so a delay of 30 seconds between sending messages was introduced using the Delayed Job queuing gem[9]. In Experiment 2, multiple messages had to be sent at predetermined times on the following morning and so the image files were generated in advance, cached them in AWS S3[10] storage containers and their associated URLs parsed to Twilio upon sending.

11.2.2.2 Class periods

To ensure reliable, accurate and scalable data on the class periods on which students were scheduled to attend, a data file of student schedules was downloaded from the school attendance database each day. It was uploaded to the application which saved details of each period for which a student was scheduled together with the date on which the schedule applied. This data enabled the application to calculate which periods the student should have attended on any date.

11.2.2.3 Attendance data changes

When attendance data was uploaded to the application, historic data was compared with the data held in the application and in the event that the two were different, the changes were saved in the Data Changes table and the corrected information saved in the Absent Periods table.

11.3 Message composition for Pilot trial

Reason for message	Message text
present but missed at least periods 5-7 (1, 5, 6, 7)	We hope you're ok. Be sure to let the office know why you had to leave early today. ShowUp4Success!
more than 15 consecutive days attendance	Three weeks and not a day missed - very good going. ShowUp4Success
present but missed at least period 7 (5, 6, 7)	Well done for coming to school today. It looks like you left early - hope all is well. Talk to the office if you really need to leave early. ShowUp4Success!
present all day Monday <30% attendance absent all day before the weekend	Well done getting to school school today - Mondays can be hard.
more than 25 consecutive days attendance	Very good - you've been in school every day for 5 weeks. Keep it up!! ShowUp4Success
more than 20 consecutive days attendance	A month, four weeks, 20 days - that's how often you've come to school without missing a day. Way to go. ShowUp4Success
present all day today >80% attendance absent part yesterday	Well done getting back to school today. Did you know you were recorded absent for some of yesterday? ShowUp4Success!
present but missed first period (1, 2)	Well done for coming to school today. Would you be interested in getting a wakeup call or text? Answer WAKEUP for more information.

present but missed at least period 7 (5, 6, 7)	Well done for coming to school today. You left early - hope all is well. Talk to the office if you really need to leave early. ShowUp4Success!
present all day today >80% attendance absent part yesterday	Well done getting back to school today. Did you know you were recorded absent for some of Thursday? ShowUp4Success!
present but missed at least periods 5-7 (4, 5, 6, 7)	We hope you're ok. Be sure to let the office know why you had to leave early today. ShowUp4Success!
present but missed at least period 7 (6, 7)	Well done for coming to school today. It looks like you left early - hope all is well. Talk to the office if you really need to leave early. ShowUp4Success!
present all day today <30% attendance absent all day yesterday	Welcome back! Great that you're ins school today! ShowUp4Success!
present but missed at least period 7 (7)	Well done for coming to school today. It looks like you left early - hope all is well. Talk to the office if you really need to leave early. ShowUp4Success!
present all day today <30% attendance absent part of yesterday	Well done - coming to school gets you closer to graduation - keep it up! ShowUp4Success!
present but missed first period (1)	Well done for coming to school today. Would you be interested in getting a wakeup call or text? Answer WAKEUP for more information.
more than 10 consecutive days attendance	Yay - two weeks without missing a day. Excellent.

present all day today <30% attendance absent all day yesterday	Terrific - well done for coming to school today! ShowUp4Success
Intro to weekly poll	Every week you'll get a message asking you to think about how much you want to go to school this week. Just answer with a number between 1 and 10.
First welcome message	When u enrolled at the OC u signed up for an attendance intervention called ShowUp4Success. U will start getting msgs now.
present all day today >80% attendance absent part yesterday	Well done getting back to school today. Did you know you were recorded absent for some of yesterday? ShowUp4Success!
more than 5 consecutive days attendance	You've been in school every day for 5 days. That's a whole week. Well done
more than 3 consecutive days attendance	3 days in school. That's the way - let's make it 5. Keep at it - ShowUp4Success
Weekly poll	Hello - how much do you want to go to school this week? Answer with score of 1-10. [1 means not at all, 10 means very much]. Just reply with your answer.

Table 41: Pilot Trial - Message rules for ADAPT intervention group

Reason for message	Message text
family - more than 25 consecutive days attendance	5 weeks. Your student at the ### School has come to school every day for 25 days in a row. Aren't they great! ShowUp4Success
family - more than 20 consecutive days attendance	Your student at the XXX School has not missed a day of school for a month. Tell them well done. ShowUp4Success
family - more than 10 consecutive days attendance	Ten days perfect attendance - you know a student at the #### School who wanted you to know how well they were doing.
New student added - added family member	This message is from a computer at the #### School. A student here gave your number for us to send you news on their attendance and successes at school. If you do not wish to receive the messages, reply STOP at any time.
New student added - added family member	The program will start in October and is called ShowUp4Success.

Table 42: Pilot Trial - Message rules for family member messages in ADAPT_group

Message Text
On average high school dropouts earn $24,492/yr but after 2 years of college can earn $40,820/yr - ShowUp4Success!
168 ## graduates last year! You can too - ShowUp4Success
On average people who don't finish high school earn $471/wk but if you do, on average you earn $785/wk after 2 years of college - ShowUp4Success!
On average people who don't finish high school earn $24,492/yr but graduates earn $33,904/yr - ShowUp4Success!
Want to be a web developer? You qualify for that at Community College in just a year- just keep coming to school so you graduate and are ready for college - ShowUp4Success!
On average high school dropouts earn $471/wk but graduates earn $652/week - ShowUp4Success!
An Investment in Knowledge Pays the Best Interest" Benjamin Franklin - ShowUp4Success!
On average people who don't complete high school earn $471/wk but graduates earn $652/week - ShowUp4Success!
Want to be an EMS tech? You qualify for that at Community College in just a year- just keep coming to school so you graduate and are ready for college - ShowUp4Success!
The harder I work, the luckier I get - Samuel Goldwyn - ShowUp4Success!

Want to be a pharmacy technician? You qualify for that at Community College in just a year- just keep coming to school so you graduate and are ready for college - ShowUp4Success!

On average, college graduates earn $1 million more in their lifetime than people who don't finish high school - ShowUp4Success!

Did you know community college only costs about $2500/year and most students get financial aid to pay for it? - ShowUp4Success!

Want to be an MRI technician? You qualify for that at Community College in just a year- just keep coming to school so you graduate and are ready for college - ShowUp4Success!

Want to be an accounting clerk? You qualify for that at Community College in just a year- just keep coming to school so you graduate and are ready for college - ShowUp4Success!

Showing up is not all of life, but it counts for a lot - Hillary Clinton - ShowUp4Success!

Did you know you get to make your own schedule at college? Ask a teacher about it tomorrow at schoolâ€¦ - ShowUp4Success!

Want to be an office administrative assistant? You qualify for that at Community College in just a year- just keep coming to school so you graduate and are ready for college - ShowUp4Success!

Did you know you get to choose which classes to take at college? Ask a teacher about it tomorrow at school... - ShowUp4Success!

To stay on the map, you've got to keep showing up - Peter Gallagher - ShowUp4Success!

On average people who don't complete high school earn $24,492/yr but after 2 years of college you can earn $40,820/yr - ShowUp4Success!

You can graduate - 168 students graduated from the ## last year. You can too - ShowUp4Success

Most of life is showing up. You do the best you can, which varies from day to day - Regina Brett - ShowUp4Success!

Education is the Most Powerful Weapon Which You Can Use to Change the World â€“ Nelson Mandela - ShowUp4Success!

Have you spoken to Ms #### about your graduation plan - see how much you have left to do before you finish - ShowUp4Success!

Want to be a paralegal? You qualify for that at Community College in just a year- just keep coming to school so you graduate and are ready for college - ShowUp4Success!

Want to be an HVAC technician? You qualify for that at Community College in just a year- just keep coming to school so you graduate and are ready for college - ShowUp4Success!

Seventy percent of success is showing up, Woody Allen - ShowUp4Success!

Want to be an electrical lineworker? You qualify for that at Community College in just a year- just keep coming to school so you graduate and are ready for college - ShowUp4Success!

Want to be an autobody refinisher? You qualify for that at Community College in just a year- just keep coming to school so you graduate and are ready for college - ShowUp4Success!

Want to be a welder? You qualify for that at Community College in just a year- just keep coming to school so you graduate and are ready for college - ShowUp4Success!

Education is Not Preparation for Life; Education is Life Itself â€“ John Dewey - ShowUp4Success!

I've found that luck is quite predictable. If you want more luck, take more chances. Be more active. Show up more often - Brian Tracy - ShowUp4Success!

Want to be a carpenter? You qualify for that at Community College in just a year- just keep coming to school so you graduate and are ready for college - ShowUp4Success!

Want to be a network administrator? You qualify for that at Community College in just a year- just keep coming to school so you graduate and are ready for college - ShowUp4Success!

Table 43: Pilot Trial - Messages sent to SERIES group

11.4 Message composition for Study One and Two – Rules matrix

See next pages

		# Consecutive days at least Part present	Consecutive Days Perfect	days at least Part Present or excused/last15	At least part present today	Perfect today	Unexcused today	Excused today	Present yesterday	Excused yesterday	At least Part Present day before yesterday	**Message choice**	**Message choice**	**Message choice**
These students have generally good attendance	**5 days perfect**		5	>=70 %		T						5 days perfect attendance !! <smily> [keep going]	5 days perfect attendance !! <smily> [careers]	
	10 days perfect		10			T						10 days perfect attendance <smily> [keep going]	10 days perfect attendance <smily> [careers]	
	15 days perfect		15			T						15 days perfect attendance! <smily>	15 days perfect attendance! <smily> [careers]	15 days perfect attendance! <smily> [ed info]
	20 days perfect		20			T						20 days perfect attendance in a row - that's a month!! well done <smily> [careers]	20 days perfect attendance in a row - that's a month!! well done <smily>[ed info]	

	30 days perfect		30			T						30 days perfect attendance in a row - that's a great achievement - well done <smily> <smily><smiley>		
This is a real improvement so more explicit praise at early stage	**3 days perfect**		3	<70 %		T						3 days perfect attendance <smily> Nice work. <smiley>[keep going]	3 days perfect attendance. Well done. <smiley><smiley>	Great! You've got perfect attendance for 3 days! <smiley> [keep going]
	5 days perfect		5	<70 %		T						Terrific!! 5 days perfect attendance <smily> [keep going]	Well done!!! <smiley> 5 days perfect attendance !! [ed info]	Great! You've got perfect attendance for 5 days! <smiley> [keep going]
This is good - not perfect but good so praise is given	**3 days in school**	3		<70 %	T							3 days at school - well done!! <smiley> [keep going]	3 days in school - very good <smiley><smiley>	Great !! You've been at school for 3 days !!!!! <smiley>

														[keep going]
	5 days in school	5		<70 %								Fantastic! 5 days in school - that's a full week <smiley>	Yay! A whole week - 5 days at school. Well done! <smiley><smiley>	Well done !!!!!!! 5 days in row at school. <smiley> [keep going]
	5 days in school	5		>=70 %	T							5 days at school in a row <smily> <keep going>	5 days at school in a row <smily> <ed info>	
	10 days in school	10			T							Hurrah! 10 days at school - 2 weeks <smily> [keep going]	Hurrah! 10 days at school - 2 weeks <smily> [ed info]	
	15 days in school	15			T							Yes ! 15 days at school every day <smily> [careers]	Nice going! 15 days at school every day <smily> [ed info]	
	20 days in school	20			T							20 days at school every single day - that's a month - well done <smily>		

	30 days in school	30			T						30 days at school every day - very well done <smily>		
	Present today, Unexcused Absent yesterday. Often absent			<=70 %	T				F		T	Well done getting to school today! [love yourself]	Great - you're back! <smiley> [keep going]	Great you're back at school today. <smiley>
	Present today, Unexcused Absent yesterday. Seldom absent			>=70 %	T				F		T	Welcome back <smily>	Great that you're back at school <smiley> [love yourself]	
	Present today and yesterday, absent two days ago VERY often absent			<=50 %	T				T		F	Two days at school - that's great <smiley> [love yourself]	Well done coming back to school again [keep going]	
	Present today missed two previous days				T				F		F	Hurrah you're back - coming back to school can be tough after a few days away - well done - [get up]	Well done - it can be hard coming back after days away from school [get up]	
	Absent today - usually at school			>=70			T		T		T	Your attendance has been excellent recently - well done <astonished> [love yourself]	You usually have good attendance. Keep it up. <astonished> [get up]	

	Absent today - generally attendance ok			50..70			T		T		T	You've been doing well at coming to school in the last few weeks. Stick with it!!! [get up]	[keep going]	
	Absent today - often absent			<50			T		T		T	<thinking>[love yourself]	Remember that the OC is self paced - you can restart your work where you left off ! <smiley>	[get up]
	Absent for 3 days - usually at school			>=70			T		F		F	Your attendance is usually very good but you've been out of school for days - that's unusual - the office may be able to help - 512 386 3300 <phone>		
	Absent for 3 days - generally attendance ok			50-70			T		F		F	It's unusual for you to be out of school so much - if you are having a problem, the office 512 386 3300 may be able to help <phone>		

	Absent for 3+ days - often absent			<50			T		F		F	Remember the OC is self paced - you can pick up where you left off when you get back <smiley> [get up]	Remember the OC lets you fastforward <fastforward> to graduation! [get up]	
	Excused absence today - first day							T		F		Sorry you couldn't come to school today - we hope you're ok <sick>		
	Excused 2+ days							T		T		<sick>[love yourself]		
	Part present for 3 days - attendance not excellent	**4**	**0**	**<=70 %**								**Terrific! <smiley> 4 days at school!! - but you've missed some classes each day - if that's not right, you could go see the office and have them fix the records - Well done <smiley>**		

	Part present for 3 days - attendance usually very good	**4**	**0**	**>70 %**								**Great - 4 days at school!! - but you've missed some classes each day - if that's not right, you could go see the office and have them fix the records <smiley>**		

11.5 Message composition for Study One and Two – Snippets for insertion

Get up again	There cannot be a crisis next week. My schedule is already full. Henry A. Kissinger
	If you could kick the person in the pants responsible for most of your trouble, you wouldn't sit for a month. Theodore Roosevelt
	“There is no failure except in no longer trying.” - Chris Bradford
	“Success is not final, failure is not fatal: it is the courage to continue that counts.” - Winston Churchill
	“Pain is temporary. Quitting lasts forever.” - Lance Armstrong
	“It’s not how far you fall, but how high you bounce that counts.” - Zig Ziglar
	“No human ever became interesting by not failing. The more you fail and recover and improve, the better you are as a person. Ever meet someone who’s always had everything work out for them with zero struggle? They usually have the depth of a puddle. Or they don’t exist.” - Chris Hardwick
	“Failure is only the opportunity to begin again, only this time more wisely.” - Henry Ford
	“Our greatest glory is not in never failing, but in rising every time we fail.” - Confucious
	“Like success, failure is many things to many people. With Positive Mental Attitude, failure is a learning experience, a rung on the ladder, a plateau at which to get your thoughts in order and prepare to try again.” - W. Clement Stone
	“Think like a queen. A queen is not afraid to fail. Failing is another steppingstone to greatness.” - Oprah Winfrey
	“I’ve missed more than 9000 shots in my career. I’ve lost almost 300 games. Twenty-six times I’ve been trusted to take the game winning shot and missed. I’ve failed over and over and over again in my life. And that is why I succeed.” - Michael Jordan

Keep Going	The world is run by those who show up - anon
	“If you can make it through the night, there's a brighter day.” ― Tupac Shakur
	“Your time is way too valuable to be wasting on people that can't accept who you are.”
	“During your life, never stop dreaming. No one can take away your dreams” ― Tupac Shakur
	“I want to grow. I want to be better. You Grow. We all grow. We're made to grow.You either evolve or you disappear.” ― Tupac Shakur
	“I know it seems hard sometimes but remember one thing. Through every dark night, there's a bright day after that. So no matter how hard it get, stick your chest out, keep ya head up.... and handle it.” ― Tupac Shakur
	“Never surrender, it's all about the faith you got: don't ever stop, just push it 'till you hit the top and if you drop, at least you know you gave your all to be true to you, that way you can never fall” ― Tupac Shakur
	“Did you hear about the rose that grew from a crack in the concrete? Proving nature's laws wrong, it learned to walk without having feet. Funny, it seems to by keeping its dreams; it learned to breathe fresh air. Long live the rose that grew from concrete when no one else even cared.” ― Tupac Shakur, The Rose That Grew from Concrete
	Seventy percent of success is showing up, Woody Allen
	Showing up is not all of life, but it counts for a lot - Hillary Clinton
	Most of life is showing up. You do the best you can, which varies from day to day - Regina Brett
	To stay on the map, you've got to keep showing up - Peter Gallagher
	I've found that luck is quite predictable. If you want more luck, take more chances. Be more active. Show up more often - Brian Tracy
	The harder I work, the luckier I get - Samuel Goldwyn

	Education is the Most Powerful Weapon Which You Can Use to Change the World – Nelson Mandela
	An Investment in Knowledge Pays the Best Interest – Benjamin Franklin
	Education is Not Preparation for Life; Education is Life Itself – John Dewey

Love yourself	"If you have the ability to love, love yourself first." ― Charles Bukowski
	"I think the reward for conformity is that everyone likes you except yourself." ― Rita Mae Brown
	"You are a true success if you can trust yourself, love yourself, and be yourself." ― Debasish Mridha
	"When you love yourself endlessly, you will find that the whole world loves you too." ― Debasish Mridha
	Beauty is when you can appreciate yourself. When you love yourself, that's when you're most beautiful. Zoe Kravitz
	"The only person who can pull me down is myself, and I'm not going to let myself pull me down anymore." ― C. JoyBell C.
	"Dare to love yourself as if you were a rainbow with gold at both ends." ― Aberjhani, Journey through the Power of the Rainbow
	"The best friend you will ever find is you. Love yourself with joy and fill your heart with bliss and happiness." ― Debasish Mridha
	"Forgive but don't forget, girl keep your head up. And when he tells you you ain't nothing, don't believe him. And if he can't learn to love you, you should leave him." ― Tupac Shakur
	When I was around 18, I looked in the mirror and said, 'You're either going to love yourself or hate yourself.' And I decided to love myself. That changed a lot of things. Queen Latifah
	"Respect, Love, and Value yourself. Always remember to be good to yourself by taking care of yourself. Make yourself a priority and know that it's okay. Don't feel guilty for loving yourself, first! You're just as important as anybody else." ― Stephanie Lahart
	"How would your life be different if…You stopped allowing other people to dilute or poison your day with their words or opinions? Let today be the day…You stand strong in the truth of

	your beauty and journey through your day without attachment to the validation of others” ― Steve Maraboli, Life, the Truth, and Being Free
	“I am my own biggest critic. Before anyone else has criticized me, I have already criticized myself. But for the rest of my life, I am going to be with me and I don't want to spend my life with someone who is always critical. So I am going to stop being my own critic. It's high time that I accept all the great things about me.” ― C. JoyBell C.
	“You are not an option, a choice or a soft place to land after a long battle. You were meant to be the one. If you can wrap yourself around the idea that you are something incredible, then you will stop excusing behaviour that rapes your very soul. You were never meant to teach someone to love you. You were meant to be loved.” ― Shannon L. Alder
	“Life is too short to waste any amount of time on wondering what other people think about you. In the first place, if they had better things going on in their lives, they wouldn't have the time to sit around and talk about you. What's important to me is not others' opinions of me, but what's important to me is my opinion of myself.” ― C. JoyBell C.

11.6 Message composition for Study One and Two – Emoji for insertion

Expression	Emoji (Windows)	Code	Description
astonished		1f632	Astonished face
sick		1f637	Face with medical mask
sick		1f912	Face with thermometer
sick		1f915	Face with head bandage
goblin		1f608	Smiling face with horns
goblin		1f47f	Imp
goblin		1f479	Japanse ogre
goblin		1f47a	Japanese goblin
rolling eyes		1f644	Face with rolling eyes
smirk		1f60f	Smirking face
persevere		1f623	Persevering face
sleepy		1f62a	Sleepy face
sleepy		1f62b	Tired face
smiley		1f47d	Extraterrestrial alien
smiley		1f47e	Alien monster
smiley		1f916	Robot face
smiley		1f600	Grinning face

smiley		1f604	Smiling face with open mouth and smiling eyes
smiley		1f60a	Smiling face with smiling eyes
smiley		1f60e	Smiling face with sunglasses
smiley		1f63a	Smiling cat face with open mouth
smiley		1f638	Grinning cat face with smiling eyes
smiley		1f63b	Smiling cat face with heart shaped eyes
smiley		1f63c	Cat face with wry smile
ok		1f44d	Thumbs up sign
ok		1f44c	OK hand signal
thinking		1f914	Thinking face
wink		1f609	Winking face
briefcase		1f4bc	Briefcase
auto		1f697	Automobile
hammer		1f528	Hammer
computer		1f4bb	Personal computer / laptop
hospital		1f3e5	Hospital
ambulance		1f691	Ambulance
highvoltage		26a1	High voltage sign
construction		1f477	Construction worker
money		1f4b0	Money bag

money		1f911	Money mouth
fastforward		23ed	Fast forward sign
phone		1f4f1	Mobile phone

11.7 Questionnaire Measures – Study One

See following page

Student ID _____ Name _____

Below is a list of words that describe feelings people have. Please read each one carefully. Then circle the answer which best describes HOW YOU FEEL RIGHT NOW. Make sure you answer every question.

	Not at all	A little	Moderately	Quite a bit	Extremely
Panicky	0	1	2	3	4
Lively	0	1	2	3	4
Confused	0	1	2	3	4
Worn out	0	1	2	3	4
Depressed	0	1	2	3	4
Downhearted	0	1	2	3	4
Annoyed	0	1	2	3	4
Exhausted	0	1	2	3	4
Mixed-up	0	1	2	3	4
Sleepy	0	1	2	3	4
Bitter	0	1	2	3	4
Unhappy	0	1	2	3	4
Anxious	0	1	2	3	4
Worried	0	1	2	3	4
Energetic	0	1	2	3	4
Miserable	0	1	2	3	4
Muddled	0	1	2	3	4
Nervous	0	1	2	3	4
Angry	0	1	2	3	4
Active	0	1	2	3	4
Tired	0	1	2	3	4
Bad tempered	0	1	2	3	4
Alert	0	1	2	3	4
Uncertain	0	1	2	3	4

Circle the answer that fits best:
I have high self-esteem.
Not very true of me 1 ---- 2 ---- 3 ---- 4 ---- 5 ---- 6 ---- 7 Very true of me.

How do you feel about your encounters with your school? Circle the answer that describes them best.

I feel that my school provides me choices and options.

1 2 3 4 5 6 7
strongly agree neutral strongly disagree

I feel understood by my teachers and staff at my school.

1 2 3 4 5 6 7
strongly agree neutral strongly disagree

My school conveys confidence in my ability to do well in my classes.

1 2 3 4 5 6 7
strongly agree neutral strongly disagree

Teachers and staff at my school encourage me to ask questions.

1 2 3 4 5 6 7
strongly agree neutral strongly disagree

My school listens to how I would like to do things.

1 2 3 4 5 6 7
strongly agree neutral strongly disagree

My school tries to understand how I see things before suggesting a new way to do things.

1 2 3 4 5 6 7
strongly agree neutral strongly disagree

Each rung of this ladder shows how various students think about their attendance.

Circle the **one part** that matches you best

I go to school a lot now and I'm never going to skip again.

I'm going to school a lot now but I'm worried I might start skipping again

I want to go to school more and I'm going to start going more now

I'm definitely going to start going to school regularly and I'm almost ready to make some plans about how to change

I'm definitely going to go to school more but I'm not ready to make any plans

I often think about having perfect attendance but I'm not making any plans to do it

I know going to school would be good for me but I don't plan to

I go to school because I have to but I don't plan to go regularly.

I don't plan to go to school regularly. I don't need to.

I'm not going to school.

School's not for me.

Student ID _____ Name _____

Did you enjoy receiving the messages?

1 2 3 4 5 6 7
Enjoyed them — Didn't care — Did not like them

How useful were the messages that you received?

1 2 3 4 5 6 7
Very useful — neutral — not useful

How easy were messages to understand?

1 2 3 4 5 6 7
Easy — neutral — Difficult

What did you think about how often you received messages?

1 2 3 4 5 6 7
Not often enough — just right — Too often

How often did you read the messages?

1 2 3 4 5 6 7
Always — sometimes — Never

How much trouble were the messages that you received?

1 2 3 4 5 6 7
Not annoying — neutral — Very annoying

What did you think about the text in the messages?

1 2 3 4 5 6 7
Very interesting — neutral — Very boring

Did you like the time that the messages were sent?

1 2 3 4 5 6 7
Very good time — neutral — Very bad time

Do you think you attended school more or less often while you received the messages?

1 2 3 4 5 6 7
More — neutral — Less

Why?

Would you like to receive the messages again next year?

Yes **No preference** **No**

Would you recommend the messages to someone starting at this school next year?

Yes **No preference** **No**

Would you recommend the messages to someone at the high school next year?

Yes **No preference** **No**

Do you remember receiving any of the messages in particular? Why?

If you received this message on a Wednesday what would it mean?

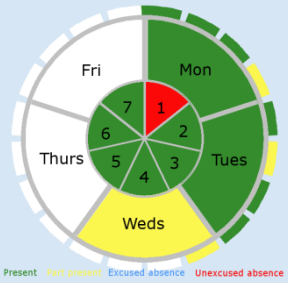
A. You had perfect attendance for the whole week

B. You missed first period today but perfect attendance otherwise

C. You missed the whole day today

D. You left early today

E. I don't know



If you received this message on a Friday what would it mean?

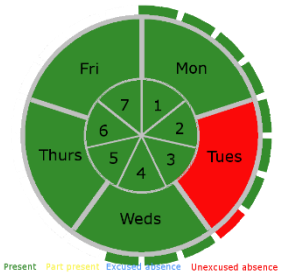
A. You had perfect attendance for the whole week

B. You missed some school today

C. You missed all day on Tuesday but perfect attendance otherwise

D. You left early today

E. I don't know



11.8 Questionnaire Measures – Study Two

See following page

Page intentionally blank

Student ID _____ Name _____

Below is a list of words that describe feelings people have. Please read each one carefully. Then circle the answer which best describes HOW YOU FEEL RIGHT NOW.
Make sure you answer every question.

	Not at all	A little	Moderately	Quite a bit	Extremely
Panicky	0	1	2	3	4
Lively	0	1	2	3	4
Confused	0	1	2	3	4
Worn out	0	1	2	3	4
Depressed	0	1	2	3	4
Downhearted	0	1	2	3	4
Annoyed	0	1	2	3	4
Exhausted	0	1	2	3	4
Mixed-up	0	1	2	3	4
Sleepy	0	1	2	3	4
Bitter	0	1	2	3	4
Unhappy	0	1	2	3	4
Anxious	0	1	2	3	4
Worried	0	1	2	3	4
Energetic	0	1	2	3	4
Miserable	0	1	2	3	4
Muddled	0	1	2	3	4
Nervous	0	1	2	3	4
Angry	0	1	2	3	4
Active	0	1	2	3	4
Tired	0	1	2	3	4
Bad tempered	0	1	2	3	4
Alert	0	1	2	3	4
Uncertain	0	1	2	3	4

Circle the answer that fits best:

I have high self-esteem.

[Self-esteem is the belief that you are at least as good as other people and you are satisfied with yourself]

Not very true of me 1 ---- 2 ---- 3 ---- 4 ---- 5 ---- 6 ---- 7 Very true of me.

How do you feel about your encounters with your school? Circle the answer that describes them best.

I feel that my school provides me choices and options.

1 2 3 4 5 6 7
strongly agree neutral strongly disagree

I feel understood by my teachers and staff at my school.

1 2 3 4 5 6 7
strongly agree neutral strongly disagree

My school conveys confidence in my ability to do well in my classes.

1 2 3 4 5 6 7
strongly agree neutral strongly disagree

Teachers and staff at my school encourage me to ask questions.

1 2 3 4 5 6 7
strongly agree neutral strongly disagree

My school listens to how I would like to do things.

1 2 3 4 5 6 7
strongly agree neutral strongly disagree

My school tries to understand how I see things before suggesting a new way to do things.

1 2 3 4 5 6 7
strongly agree neutral strongly disagree

Each rung of this ladder shows how various students think about their attendance.

Circle the **one part** that matches you best

I go to school a lot now and I'm never going to skip again.

I'm going to school a lot now but I'm worried I might start skipping again

I want to go to school more and I'm going to start going more now

I'm definitely going to start going to school regularly and I'm almost ready to make some plans about how to change

I'm definitely going to go to school more but I'm not ready to make any plans

I often think about having perfect attendance but I'm not making any plans to do it

I know going to school would be good for me but I don't plan to

I go to school because I have to but I don't plan to go regularly.

I don't plan to go to school regularly. I don't need to.

I'm not going to school.

School's not for me.

What time do you need to wake up to get the school in time for your first class?

_____

Student ID _____ Name _____

Did you enjoy receiving the messages?

1 2 3 4 5 6 7
Enjoyed them Didn't care Did not like them

How useful were the messages that you received?

1 2 3 4 5 6 7
Very useful neutral not useful

How easy were messages to understand?

1 2 3 4 5 6 7
Easy neutral Difficult

What did you think about how often you received messages?

1 2 3 4 5 6 7
Not often enough just right Too often

How often did you read the messages?

1 2 3 4 5 6 7
Always sometimes Never

How much trouble were the messages that you received?

1 2 3 4 5 6 7
Not annoying neutral Very annoying

What did you think about the text in the messages?

1 2 3 4 5 6 7
Very interesting neutral Very boring

Did you like the time that the messages were sent?

1 2 3 4 5 6 7
Very good time neutral Very bad time

Do you think you attended school more or less often while you received the messages?

1 2 3 4 5 6 7
More neutral Less

Why?

Would you like to receive the messages again next year?

Yes No preference No

Would you recommend the messages to someone starting at this school next year?

Yes No preference No

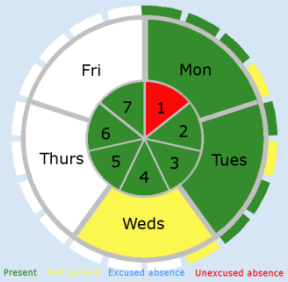
Would you recommend the messages to someone at the high school next year?

Yes No preference No

Do you remember receiving any of the messages in particular? Why?

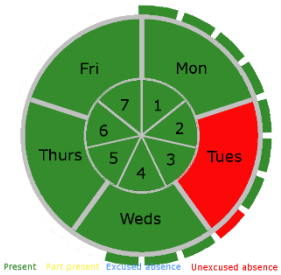
If you received this message on a Wednesday what would it mean?

A. You had perfect attendance for the whole week
B. You missed first period today but perfect attendance otherwise
C. You missed the whole day today
D. You left early today
E. I don't know



If you received this message on a Friday what would it mean?

A. You had perfect attendance for the whole week
B. You missed some school today
C. You missed all day on Tuesday but perfect attendance otherwise
D. You left early today
E. I don't know



Student ID _____ Nobre _____

A continuación se muestra una lista de palabras que describen sentimientos que tiene la gente. Por favor, lea cuidadosamente cada uno. Luego marque la respuesta que mejor describa cómo se siente ahora. Asegúrese de contestar todas las preguntas.

	De ningún modo	Un poco	moderadamente	Bastante	Extremadamente
Lleno de pánico	0	1	2	3	4
Animado	0	1	2	3	4
Confuso	0	1	2	3	4
Desgastado	0	1	2	3	4
Deprimido	0	1	2	3	4
Desanimado	0	1	2	3	4
Irritado	0	1	2	3	4
Agotado	0	1	2	3	4
Mezclado	0	1	2	3	4
Soñoliento	0	1	2	3	4
Amargo	0	1	2	3	4
Infeliz	0	1	2	3	4
Ansioso	0	1	2	3	4
Preocupado	0	1	2	3	4
Energético	0	1	2	3	4
Miserable	0	1	2	3	4
Embrollado	0	1	2	3	4
Nervioso	0	1	2	3	4
Enojado	0	1	2	3	4
Activo	0	1	2	3	4
Cansado	0	1	2	3	4
Malhumorado	0	1	2	3	4
Alerta	0	1	2	3	4
Incierto	0	1	2	3	4

Marca la respuesta que se ajuste mejor:

Tengo una alta autoestima.

[La autoestima es la creencia de que son al menos tan bueno como otras personas y está satisfecho con uno mismo]

No es muy cierto de mí 1 ---- 2 ---- 3 ---- 4 ---- 5 ---- 6 ---- 7 Muy cierto de mí.

¿Cómo se siente acerca de sus encuentros con su escuela? Marca la respuesta que los describe mejor.

Siento que mi escuela me ofrece alternativas y opciones.

1 2 3 4 5 6 7
muy de acuerdo neutral muy en desacuerdo

Me siento entendido por mis maestros y el personal en mi escuela.

1 2 3 4 5 6 7
muy de acuerdo neutral muy en desacuerdo

Mi escuela transmite confianza en mi capacidad para hacerlo bien en mis clases.

1 2 3 4 5 6 7
muy de acuerdo neutral muy en desacuerdo

Los maestros y el personal en mi escuela me animan a hacer preguntas.

1 2 3 4 5 6 7
muy de acuerdo neutral muy en desacuerdo

Mi escuela escucha cómo me gustaría hacer las cosas.

1 2 3 4 5 6 7
muy de acuerdo neutral muy en desacuerdo

Mi escuela trata de entender cómo veo las cosas antes de sugerir una nueva manera de hacer las cosas.

1 2 3 4 5 6 7
muy de acuerdo neutral muy en desacuerdo

Cada peldaño de esta escalera muestra cómo varios estudiantes piensan acerca de su asistencia.

Un círculo por una parte que mejor se adapte

¿A qué hora tiene que despertar para llegar a la escuela a tiempo para su primera clase?

_____

Voy a la escuela mucho y nunca me voy a omitir de nuevo.

Voy a la escuela mucho ahora pero me preocupa que podría empezar a omitiendo de nuevo

Yo quiero ir a la escuela cada vez que voy a empezar a ir más ahora

Definitivamente voy a empezar a ir a la escuela regularmente y estoy casi listo para hacer algunos planes acerca de cómo cambiar

Definitivamente voy a ir a la escuela más, pero no estoy dispuesto a hacer planes

A menudo pienso en tener asistencia perfecta, pero no estoy haciendo planes para hacerlo

Sé que voy a la escuela sería bueno para mí, pero yo no planeo

Voy a la escuela porque tengo que, pero no planeo ir habitualmente.

No planeo ir a la escuela con regularidad. Yo no necesito.

No voy a la escuela.
La escuela no es para mí.

Student ID _____ Nombre _____

¿Le gustó la recepción de los mensajes?

1 2 3 4 5 6 7
disfrutamos mucho de ellas No se preocupan No como ellos

¿Qué tan útiles fueron los mensajes que ha recibido?

1 2 3 4 5 6 7
Muy útil neutral Inútil

¿Qué tan fácil eran mensajes de entender?

1 2 3 4 5 6 7
Fácil neutral Difícil

¿Qué pensaste sobre la frecuencia con que recibió mensajes?

1 2 3 4 5 6 7
No con la suficiente frecuencia solo bien Con demasiada frecuencia

¿Con qué frecuencia usted lee los mensajes?

1 2 3 4 5 6 7
Siempre a veces Nunca

La cantidad de problemas fueron los mensajes que ha recibido?

1 2 3 4 5 6 7
No molesta neutral Muy molesto

¿Qué le parece el texto de los mensajes?

1 2 3 4 5 6 7
Muy interesante neutral Muy aburrido

¿Le gustó el momento en que se enviaron los mensajes?

1 2 3 4 5 6 7
Muy buen tiempo neutral Muy mal momento

¿Cree que asiste a la escuela más o menos frecuencia, mientras que recibió los mensajes?

1 2 3 4 5 6 7
Más neutral Menos

¿Por qué?

¿Le gustaría recibir los mensajes de nuevo el año que viene?

Sí **Sin preferencias** **No**

¿Recomendaría los mensajes a alguien que empieza en esta escuela el próximo año?

Sí **Sin preferencias** **No**

¿Recomendaría los mensajes a alguien en la escuela secundaria el próximo año?

Sí **Sin preferencias** **No**

¿Recuerdas recibir cualquiera de los mensajes en particular? ¿Por qué?

Si ha recibido este mensaje en un miércoles, ¿qué significaría?

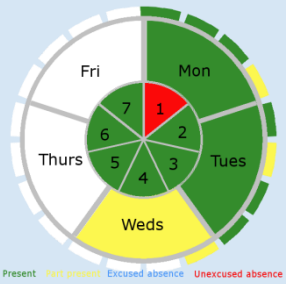
A. Usted tuvo asistencia perfecta durante toda la semana

B. Se perdió primer periodo de hoy, pero de lo contrario asistencia perfecta

C. Se perdió todo el día de hoy

D. Usted dejó la madrugada de hoy

E. No sé



Si ha recibido este mensaje en un viernes, ¿qué significaría?

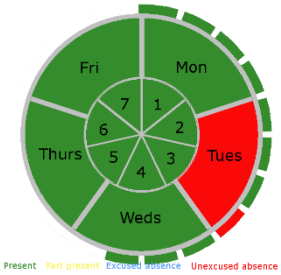
A. Usted tuvo asistencia perfecta durante toda la semana

B. Se ausentó al colegio hoy

C. Se perdió todo el día el martes, pero la asistencia perfecta de lo contrario

D. Usted dejó la madrugada de hoy

E. No sé



11.9 Study One – Analysis of data excluding pilot participants

Repeating the analysis and excluding nine participants who had been part of a different text message support experiment at the start of the year showed similar trends but, possibly due to the lower number of participants, significance and effect size were reduced.

Because the effects and trends were similar to the whole data set, it was assumed that the exposure to the pilot trial (which was a different intervention and delivered several months earlier with a gap of several months before exposure to the intervention in this experiment) had no effect and the whole dataset was used for the remainder of the analysis.

This section contains the same analysis of the dataset as performed in section 7.3.

11.9.1 All day absences: Percentage of days when absent all day (unexcused) - excluding pilot participants

The average percentage of days when students were absent all day was higher in the control group (n=23, M=16.80%, sd=20.25) than either of the treatment groups (SDT: n=23, M=8.34%, sd=9.81 and FB: n=21, M=9.152%, sd=9.47) after exposure to the messages. See Figure 34.

Two way ANOVA analysis did not find a significant difference between the groups, $F(2,119)=2.04$, $p=0.1$. Difference between pre and post groups was significant, $F(1,119)=3.95$, $p=0.05$ but not the interaction, $F(2,119)=1.41$, $p=.0.2$.

Cohen's d effect sizes were medium and small: SDT vs Control -0.53 (95% CI: -1.1 – 0.073) and FB vs Control -0.4768 (95% CI: -1.1 – 0.14) with negligible effect sizes when comparing SDT and FB). See Table 44

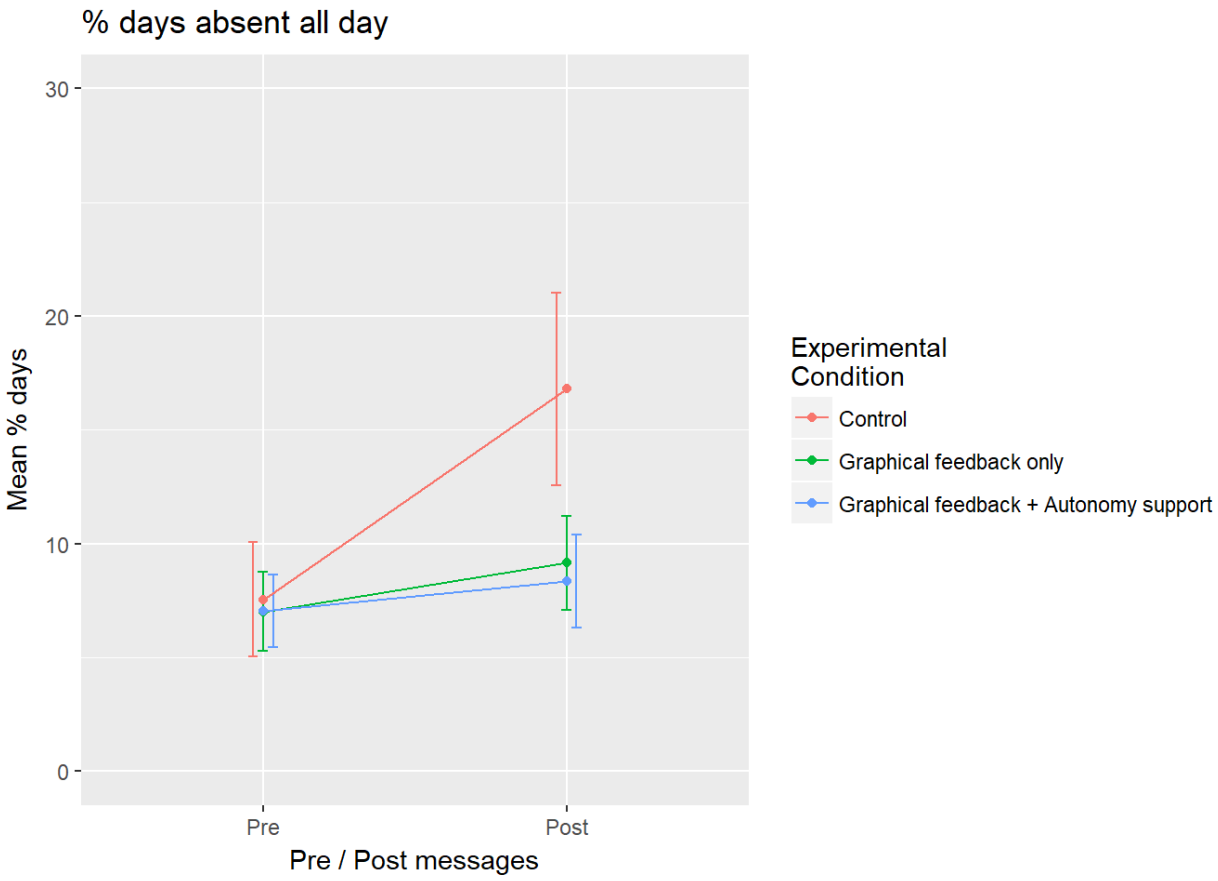


Figure 34: Study One – Proportion of days absent all day (Excluding pilot participants)

11.9.2 No absences: Percentage of days with no unexcused absences (excluding pilot participants)

When we measured the proportion of days with no unexcused absences there is a similar pattern with lower average attendance rates in the control group (n=23, M=72.48%, sd=23.39) compared with the treatment groups (SDT: n=23, M=79.26%, sd=14.85 and FB: n=17, M=80.76%, sd=17.71). See Figure 35. Two way ANOVA analysis did not find a significant difference between the groups, $F(2,119)=1.21$, $p=0.3$.

Cohen's d effect sizes were small: SDT vs Control 0.35 (95% CI: -0.26 – 0.94) and FB vs Control 0.40 (95% CI: -0.22 – 1.0) with negligible effect sizes when comparing SDT and FB). See Table 44.

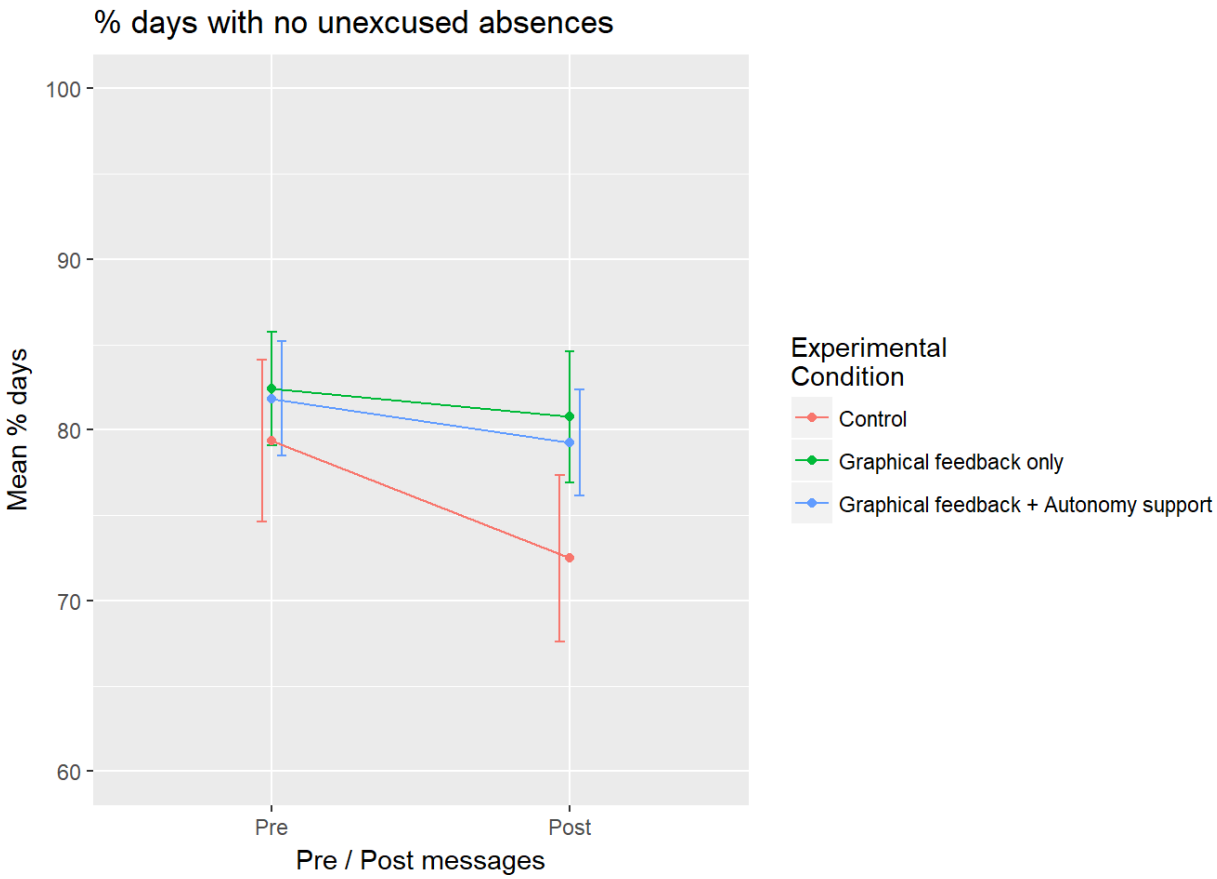


Figure 35: Study One – Proportion of days with no absences (Excluding pilot participants)

	Treatment						ANOVA		Effect size (Cohen's d) (95% CI)
	SDT		FB		Control				
	Pre (N=21) Mean (sd)	Post (N=23) Mean (sd)	Pre (N=17) Mean (sd)	Post (N=21) Mean (sd)	Pre (N=20) Mean (sd)	Post (N=23) Mean (sd)	F(2,119) Group	F(2,119) PrePost	
% days no unexcused absences	81.84 (15.31)	79.26 (14.58)	82.43 (13.73)	80.76 (17.71)	79.38 (21.28)	72.48 (23.39)	1.214	1.347	SDT/CON: 0.35 (-0.25 – 0.94) FB/CON 0.40(-0.22 – 1.0) SDT/FB -0.092 (-0.70 – 0.52)
% days unexcused all day	7.048 (7.328)	8.340 (9.807)	7.021 (7.120)	9.152 (9.472)	7.544 (11.24)	16.80 (20.25)	2.037	**3.952** *	SDT/CON -0.53 (-1.1 – 0.073) FB/CON -0.48 (-1.1 – 0.14) SDT/FB -0.084 (-0.69 – 0.53)
% classes missed with unexcused absence	10.31 (9.385)	12.40 (11.88)	10.41 (9.427)	12.42 (11.75)	11.29 (12.79)	19.38 (20.37)	1.364	2.959	SDT/CON -0.42 (-1.0 – 0.18) FB/CON -0.41 (-1.03 - .20) SDT/FB -0.0019 (-0.61 – 0.61)

*** p<.05**

Table 44: Study One – Absence rates (Excluding pilot participants)

11.9.3 Classes missed: percentage of scheduled classes missed with unexcused absence (excluding pilot participants)

When number of classes for which a student was scheduled was compared to the number of classes in which they were present) there was a similar pattern with lower average attendance rates in the control group (n=23, M=19.38%, sd=20.37) compared with the treatment groups (SDT: n=23, M=12.40%, sd=11.88 and FB: n=21, M=12.42%, sd=11.75). See Figure 36.

Two-way ANOVA analysis did not show a significant difference between the groups, F (2,119)=1.36, p=0.3. Cohen's d effect sizes were small: SDT vs Control 0.-42 (95% CI: -1.0 – 0.18) and FB vs Control 0.41 (95% CI: -1.0 – 0.20) with negligible effect sizes when comparing SDT and FB). See

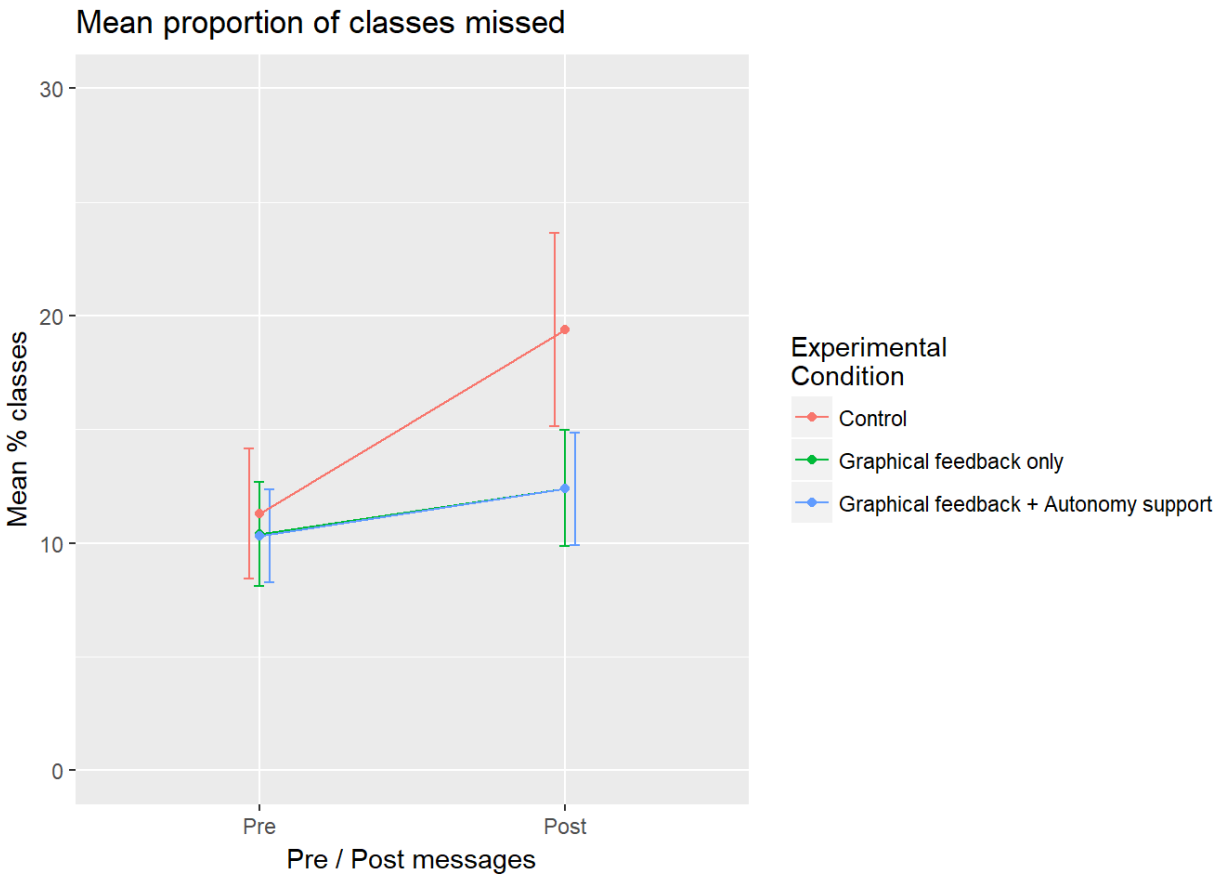


Figure 36: Study One – Percentage of classes missed (excluding pilot participants)

11.10 Results – Study One – Questionnaire Data

		Before sending messages			After sending messages		
		Control	**Simple feedback**	**Autonomy supporting feedback**	**Control**	**Simple feedback**	**Autonomy supporting feedback**
	N	23	24	27	16	16	19
	Self esteem	4.55 (1.64)	4.61 (1.64)	4.73 (1.93)	5.27 (1.49)	4.87 (1.64)	4.94 (1.73)
		F(2,66) = 0.0646, p=0.9			F(2,45)=0.257, p=0.8		
	Truancy ladder	8.03 (1.88)	8.09 (1.44)	8.35 (1.81)	8.56 (1.67)	8.22 (1.66)	8.19 (1.60)
		F(2,66)=0.237, p=0.8			F(2,45)=0.256, p=0.8		
	Autonomy	3.39 (1.59)	3.75 (1.60)	3.23 (1.39)	3.63 (1.89)	2.85 (2.00)	3.14 (2.05)
		F(2,66=0.744, p=0.5			F(2,48)=0.632, p=0.5		
Mood survey	**Anger**	0.848 (1.09)	0.786 (0.859)	0.769 (0.890)	0.349 (0.481)	0.719 (0.811)	0.566 (0.655)
		F(2,66)=0.047,p=1.0			F(2,48)=1.26, p=0.3		
	Confusion	0.609 (0.639)	0.809 (0.848)	0.620 (0.639)	0.547 (0.458)	0.672 (0.669)	0.566 (0.600)
		F(2,63)=0.602, p=0.6			F(2,48)=0.217, p=0.8		
	Depression	0.772 (1.09)	0.510 (0.883)	0.500 (0.639)	0.469 (0.576)	0.531 (0.700)	0.276 (0.311)
		F(2,66)=0.730,p=0.5			F(2,48)=1.07, p=0.4		
	Fatigue	1.57 (1.12)	1.44 (1.08)	1.77 (1.00)	1.05 (0.857)	1.39 (1.245)	1.14 (0.875)
		F(2,66)=0.619, p=0.5			F(2,48)=0.505, p=0.6		
	Tension	0.754 (0.680)	0.854 (1.07)	0.917 (0.866)	1.03 (1.00)	1.05 (0.932)	0.943 (0.957)
		F(2,66)=0.210, p=0.8			F(2,48)=0.060, p=0.9		
	Vigour	1.917 (1.132)	2.115 (0.930)	1.886 (1.039)	2.11 (0.98)	2.18 (0.73)	2.18 (0.98)
		F(2,66)=0.354, p=0.7			F(2,48)=0.0301, p-=1.0		

Table 45: Study One - Questionnaire data

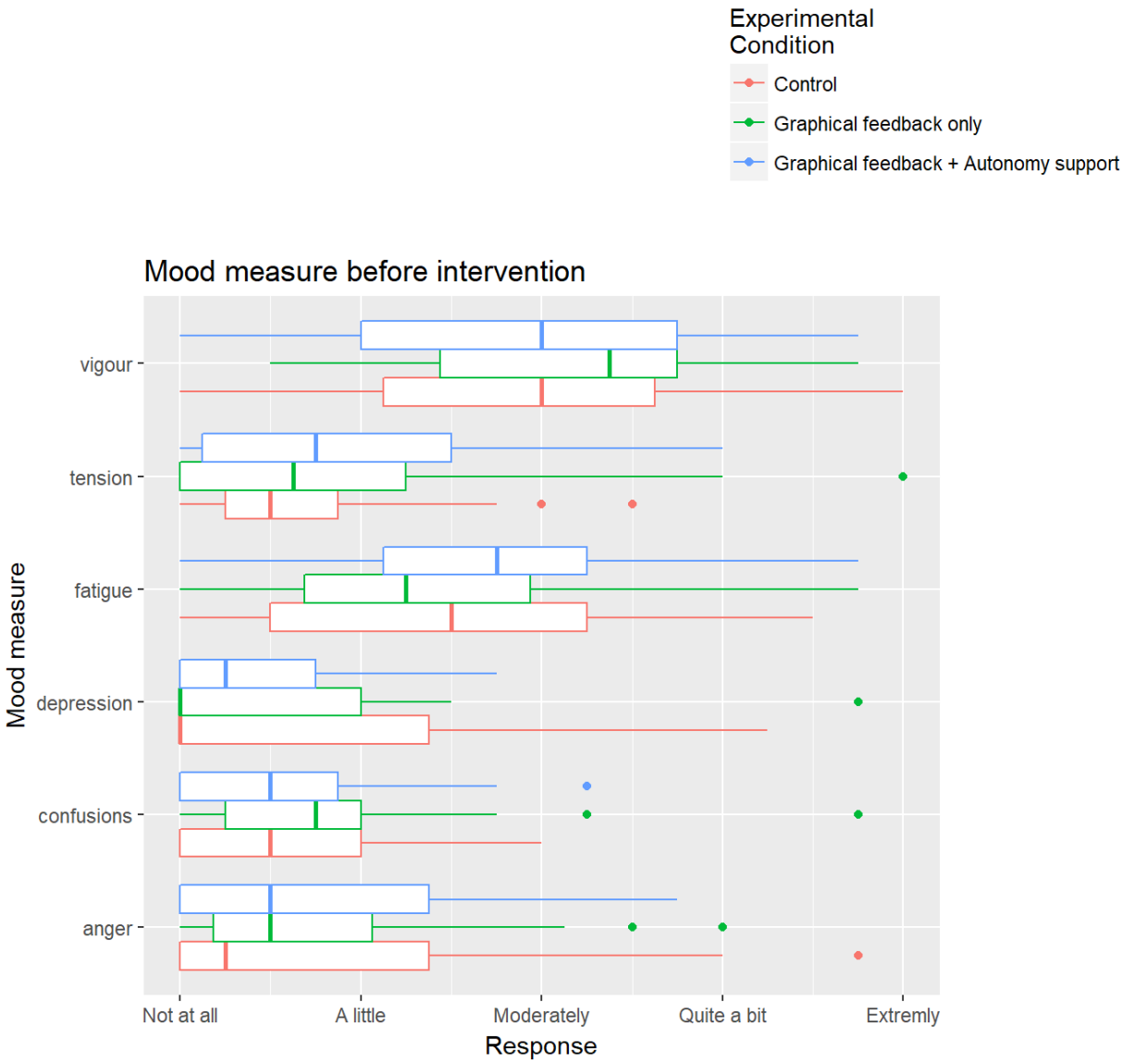


Figure 37: Study One - Pre-intervention mood measures

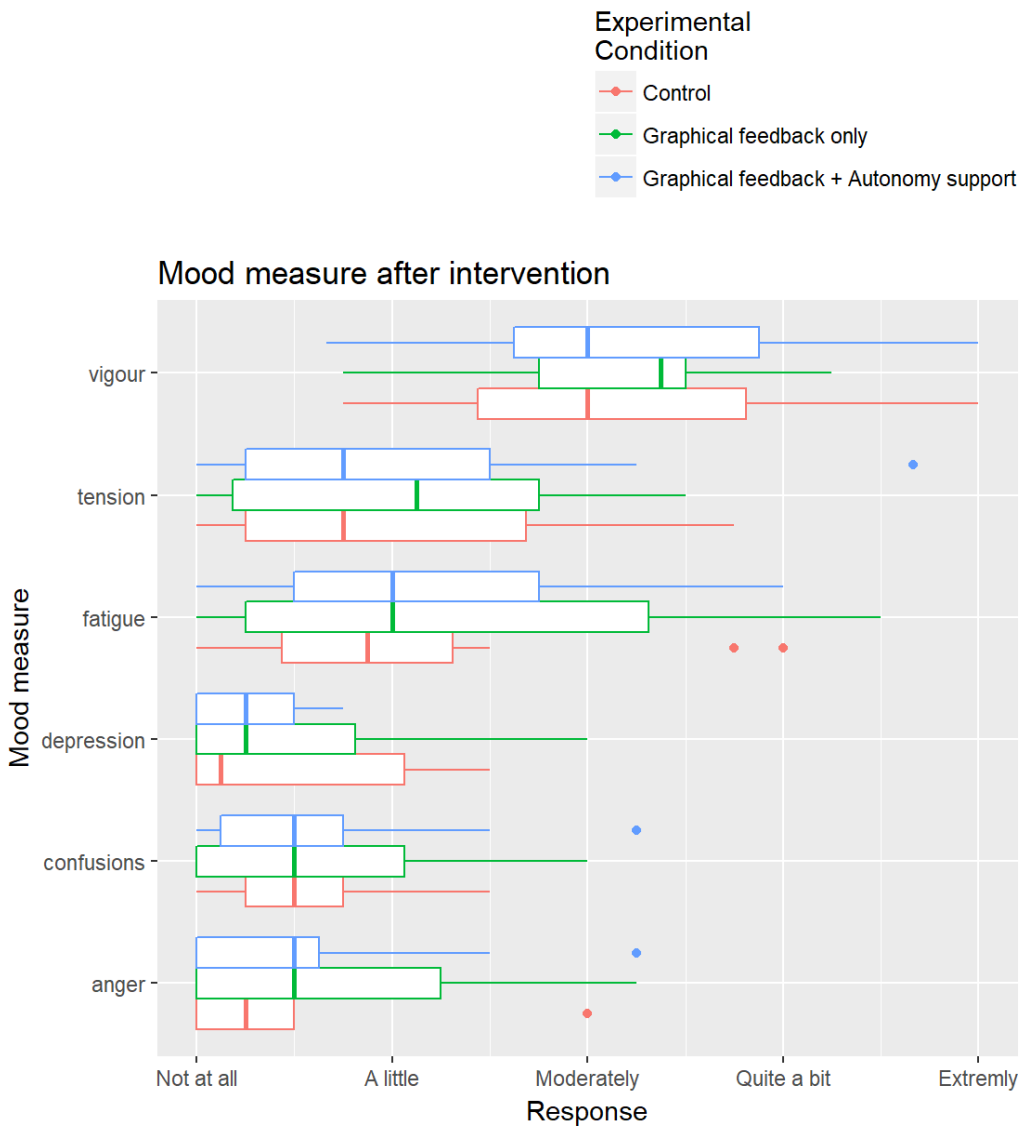


Figure 38: Study one - Post intervention mood measures

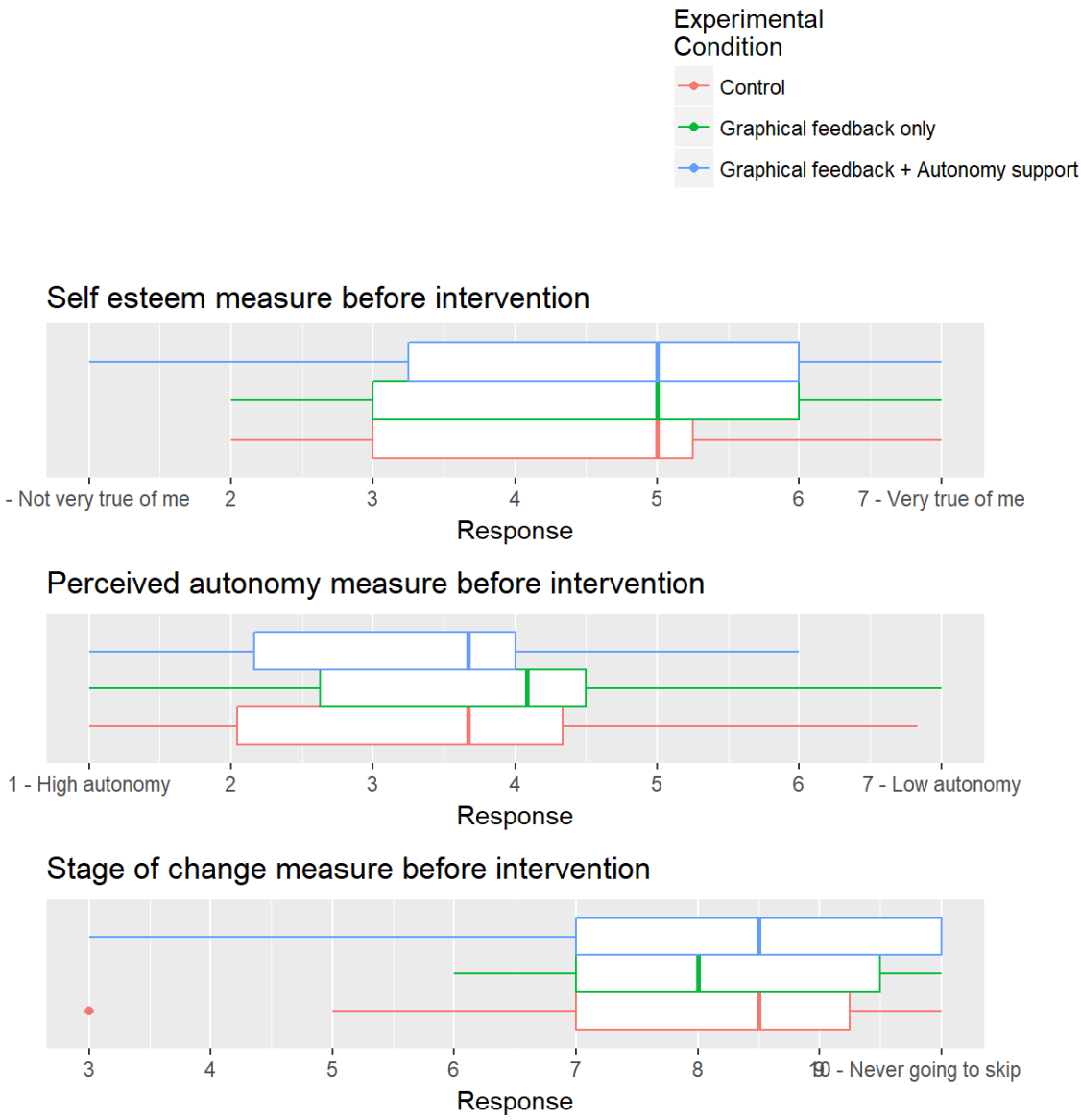


Figure 39: Study One - Pre-intervention measures of self-esteem, perceived autonomy and stage of change

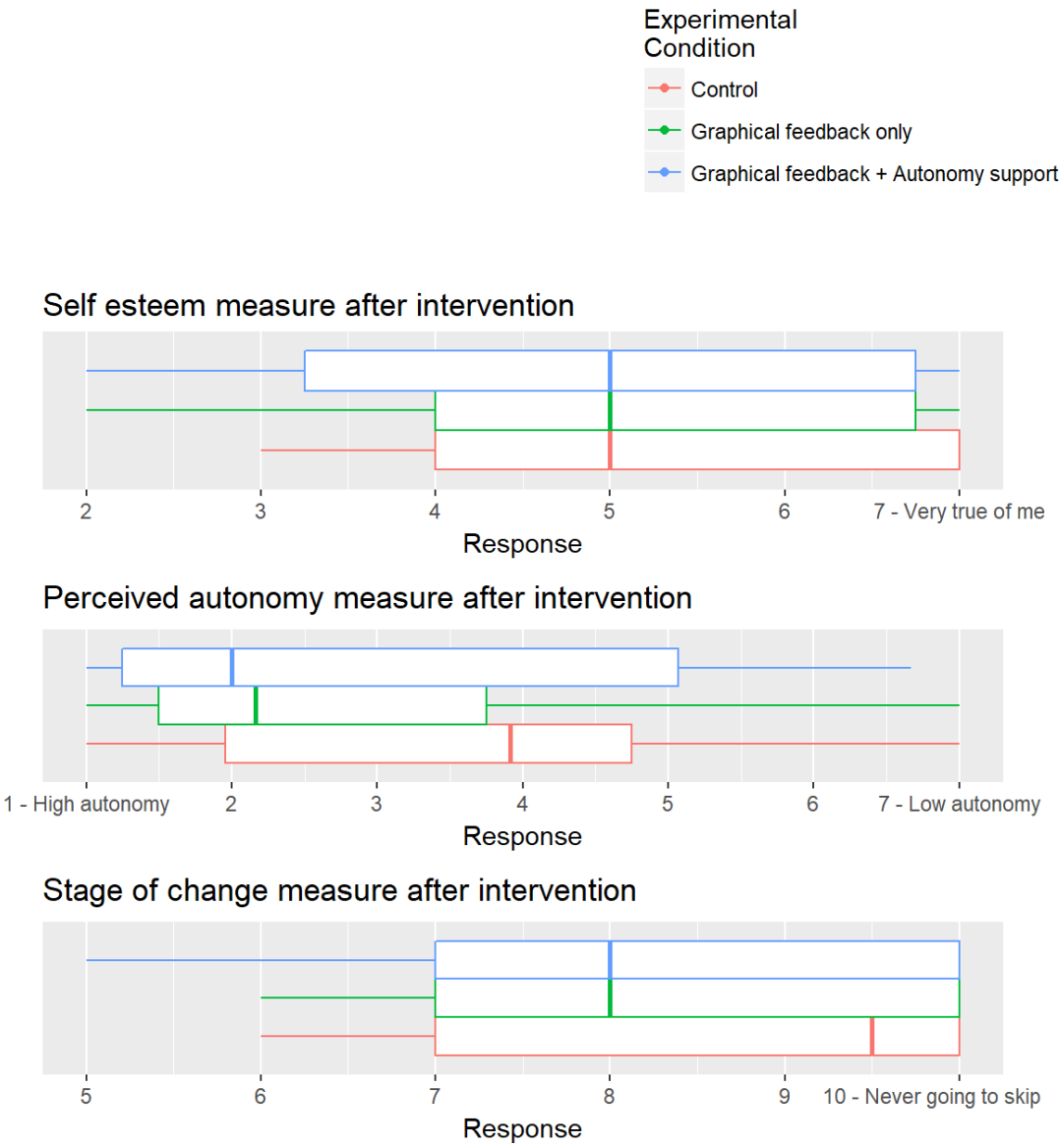


Figure 40: : Study One - Post intervention measures of self-esteem, perceived autonomy and stage of change

11.11 Results – Study One – Acceptability measures

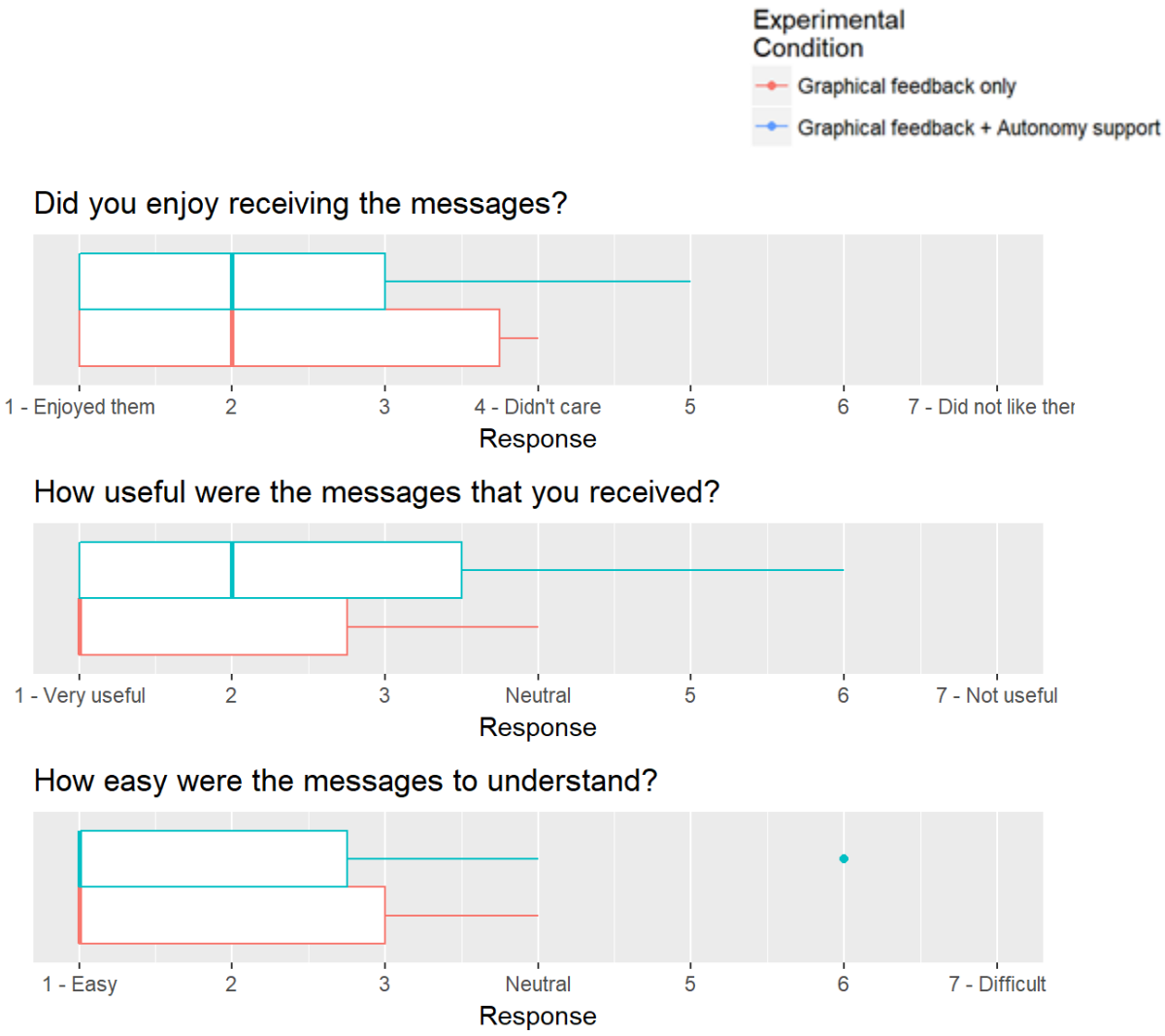


Figure 41: Study One - Distribution of answers to acceptability questionnaire

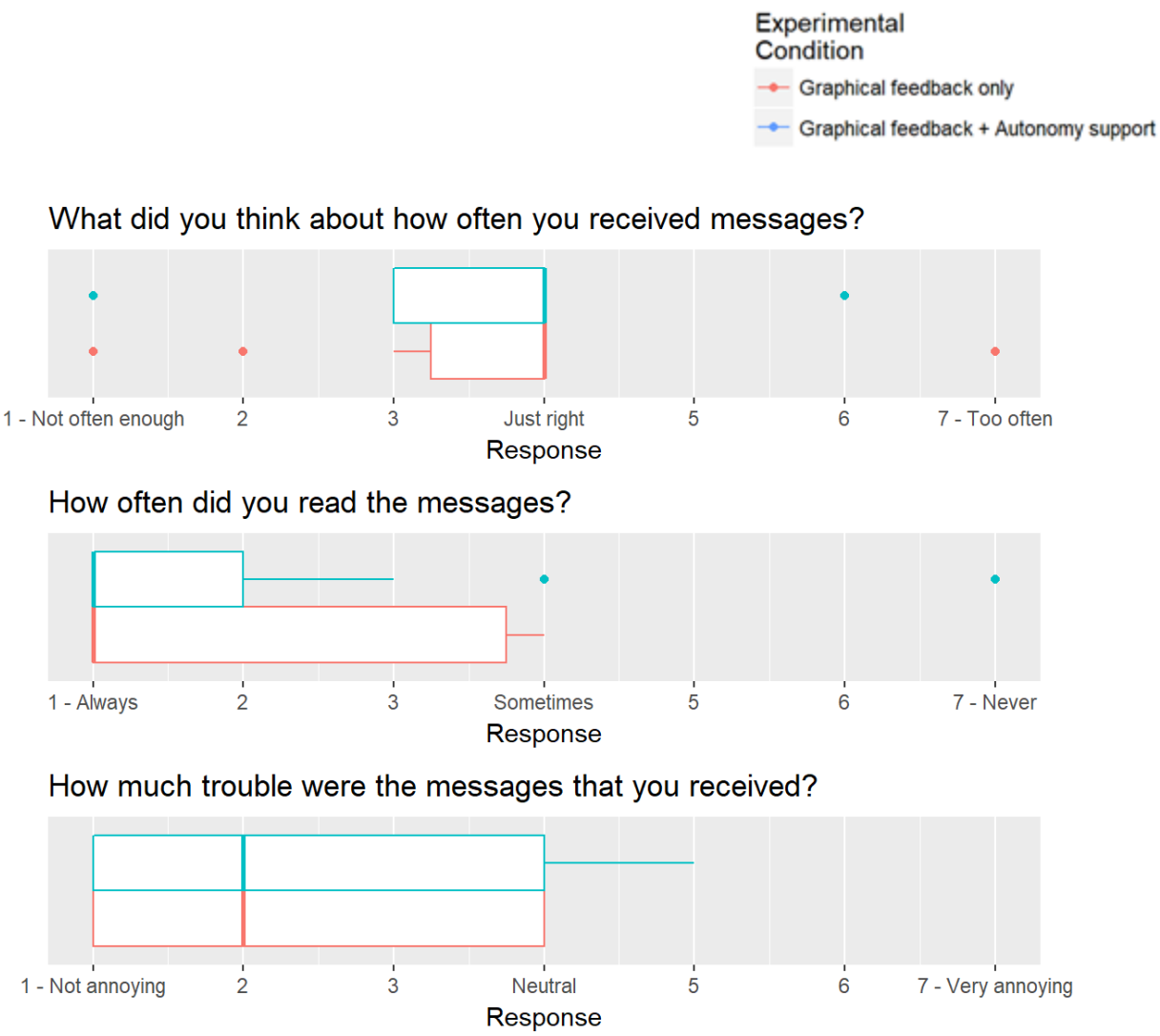


Figure 42: Study One - Distribution of answers to acceptability questionnaire

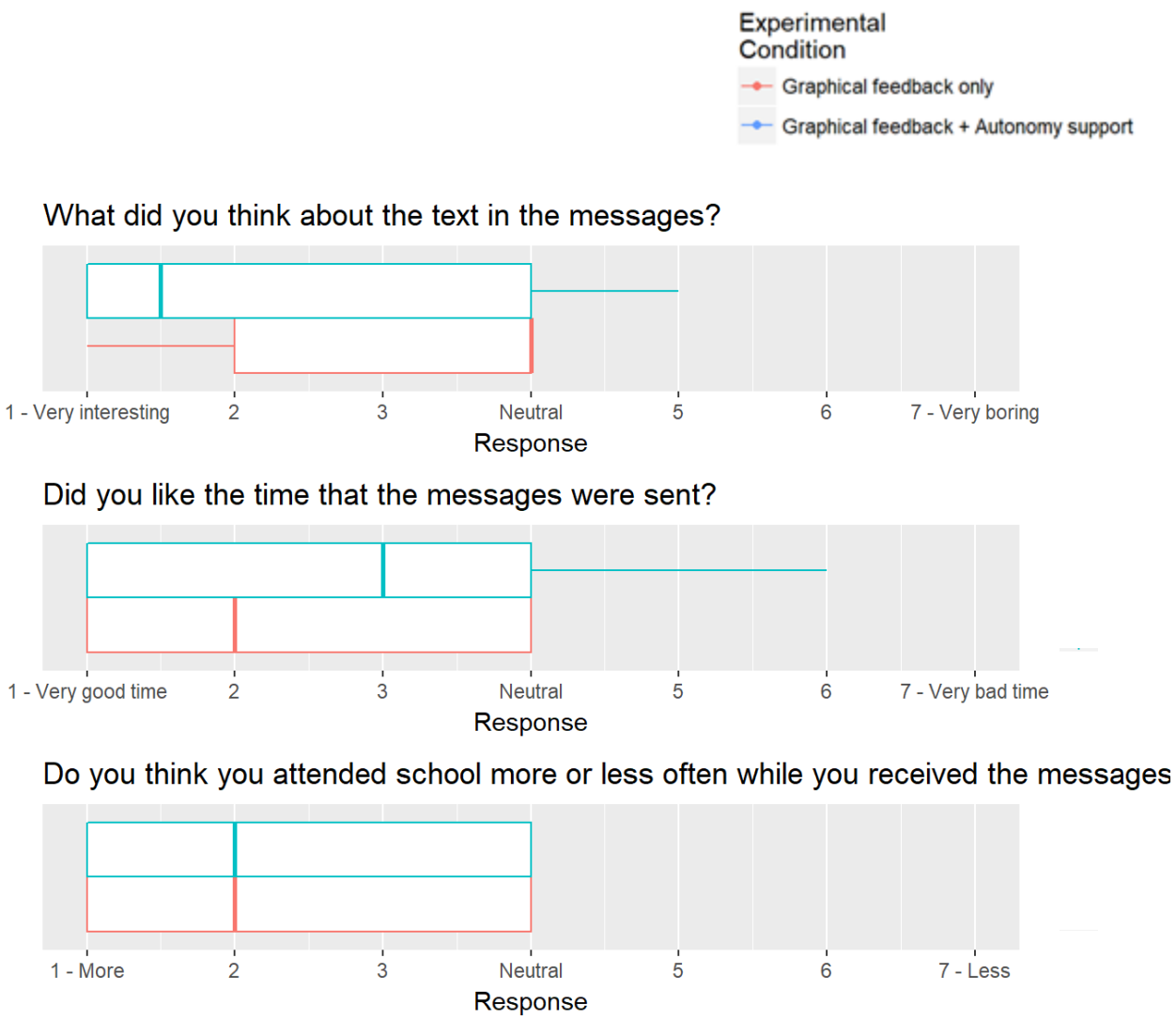


Figure 43: Study One - Distribution of answers to acceptability questionnaire

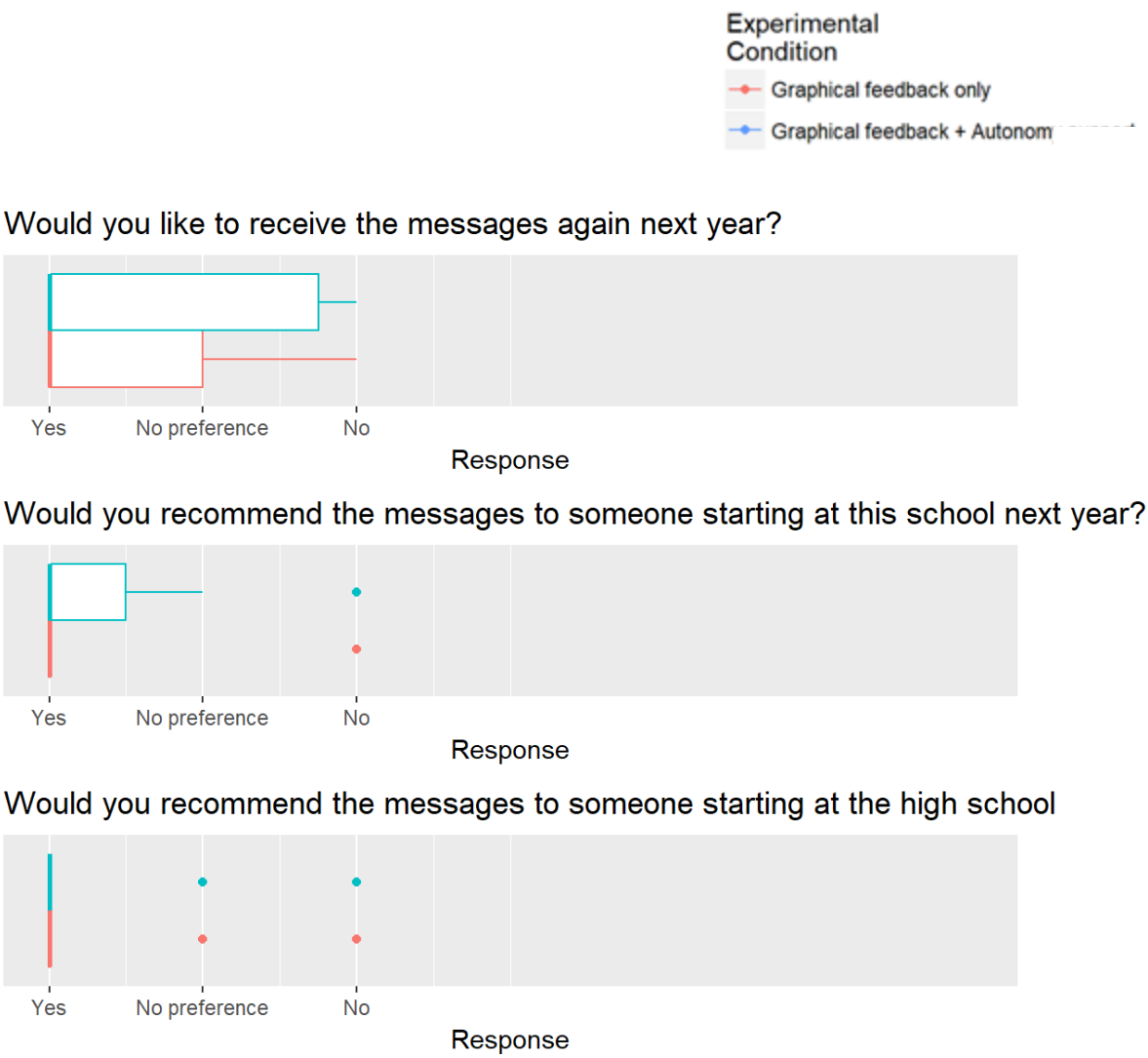


Figure 44: Study One - Distribution of answers to acceptability questionnaire

	Graphical Feedback only GRAPHICAL Mean (sd)	**Graphical Feedback + autonomy support GRAPHIC + AUTMY Mean (sd)**	**ANOVA**
N	14	19	
Did you enjoy receiving the messages?	2.36 (1.28)	2.26 (1.32)	F(1,31)=0.0417, p=0.8
How useful were the messages that you received?	1.86 (1.17)	2.32 (1.67)	F(1,31)=0.7751, p=0.4
How easy were messages to understand?	1.93 (1.32)	2.06 (1.51)	F(1,30)=0.0616, p=0.8
What did you think about how often you received messages?	3.71 (1.33)	3.47 (1.50)	F(1,31)=0.2275, p=0.6
How often did you read the messages?	2.07 (1.38)	1.89 (1.56)	F(1,30)=0.118, p=0.7
How much trouble were the messages that you received?	2.36 (1.45)	2.37 (1.42)	F(1,31)=0, p=1.0
What did you think about the text in the messages? (Interesting or boring)	3 (1.30)	2.33 (1.49)	F(1,30)=1.75, p=0.2
Did you like the time that the messages were sent?	2.36 (1.39)	2.53 (1.54)	F(1,31)=0.1052, p=0.7
Do you think you attended more?	2.43 (1.34)	2.33 (1.37)	F(1,30)=0.0387, p=0.8
Do you want ro receive messages next year?	1.64 (0.84)	1.67 (0.97)	F(1,30)=0.0058, p=0.9

Recommend at this school	1.14 (0.53)	1.42 (0.76)	F(1,31)=1.348, p=0.2
Recommend at regular high school	1.21 (0.57)	1.16 (0.51)	F(1,31)=0.0894, p=0.8
Question 1 correct			
Yes	6 (43%)	8 (42%)	F(1,31)=0.0018, p=1.0
No	8 (57%)	11 (58%)	
Question 2 correct			
Yes	5 (36%)	8 (42%)	F(1,31)=1.5669, p=0.2
No	9 (64%)	11 (58%)	

Table 46: Study One - Acceptability Questionnaire mean scores

11.12 Results – Study Two – Questionnaire data

Tabular data for questionnaire data is included in section 8.3.5, Table 38.

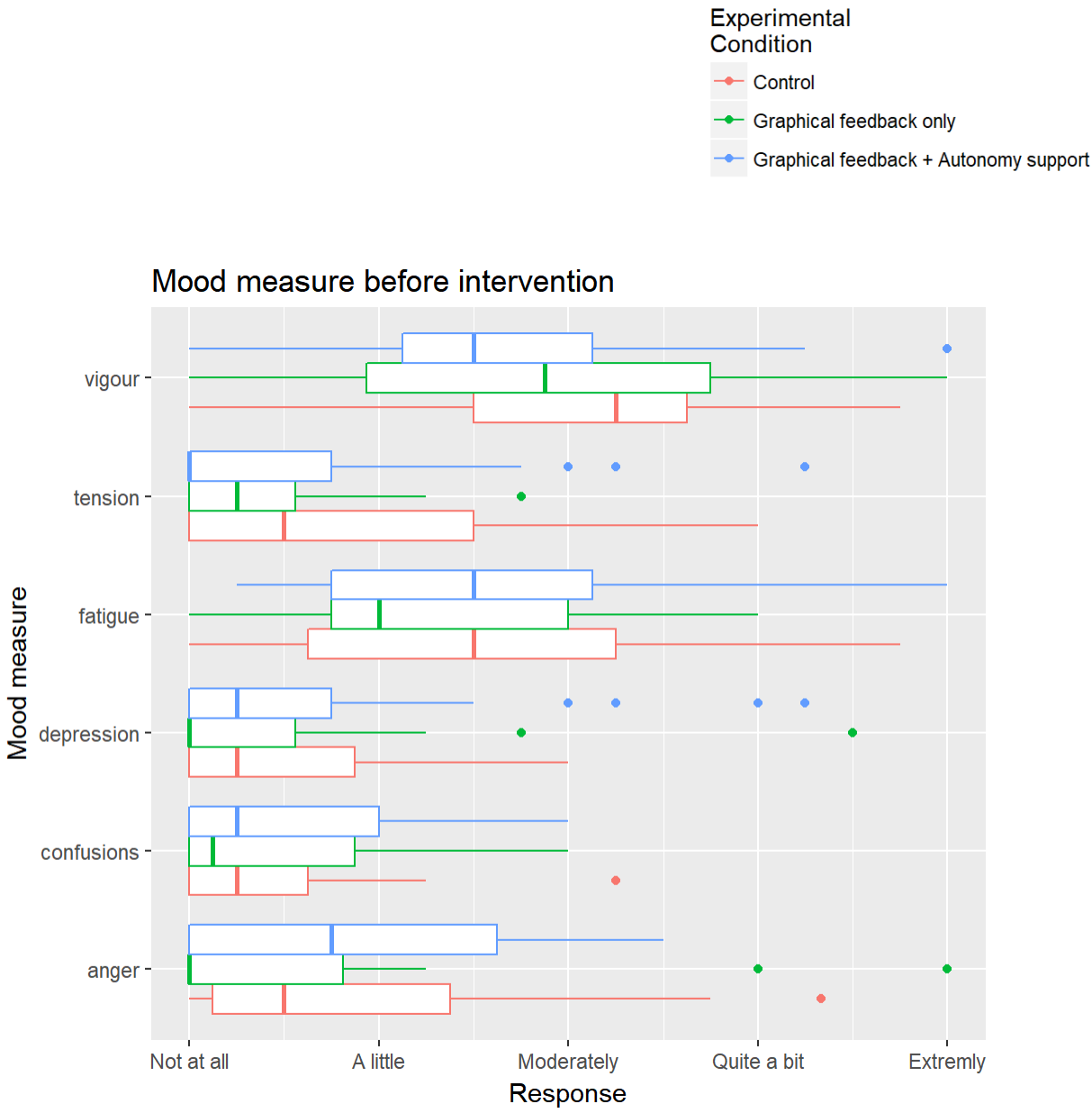


Figure 45: Study Two - Pre-intervention mood measures

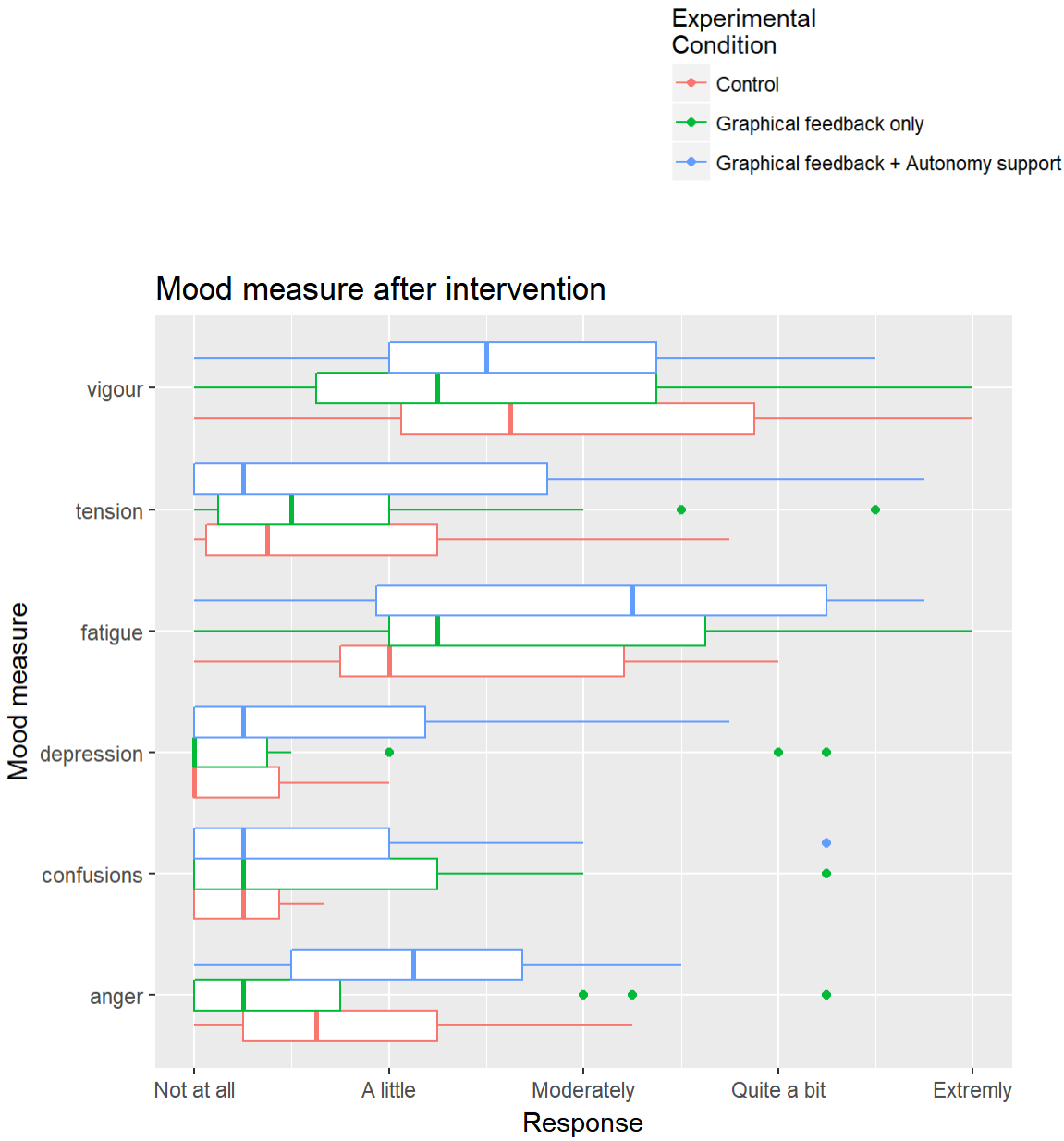


Figure 46: Study Two - Post-intervention mood measures

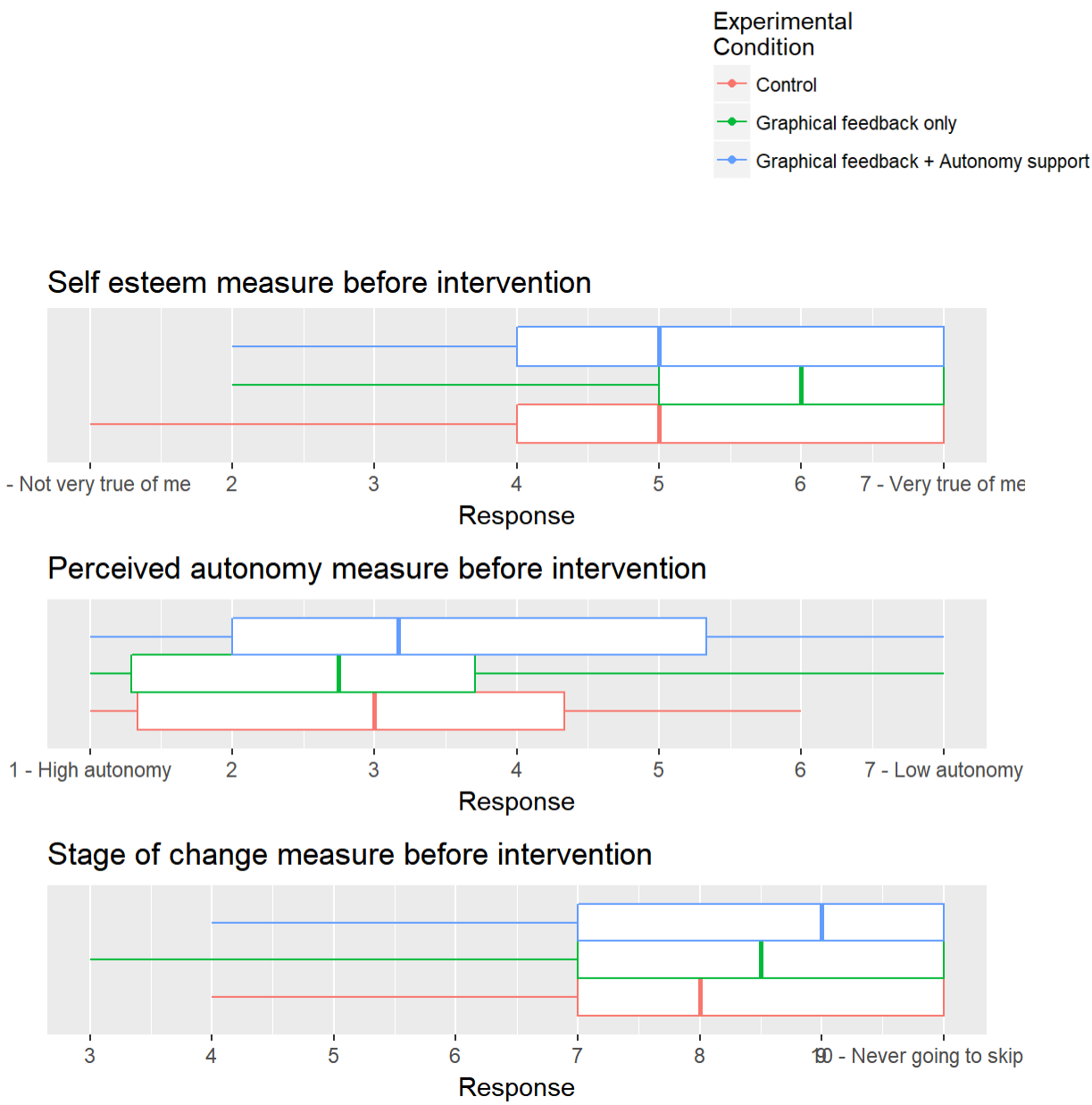


Figure 47: Study Two - Pre-intervention measures of self-esteem, perceived autonomy and stage of change

Figure 48: Study Two - Post-intervention measures of self-esteem, perceived autonomy and stage of change

11.13 Results – Study Two Acceptability measures

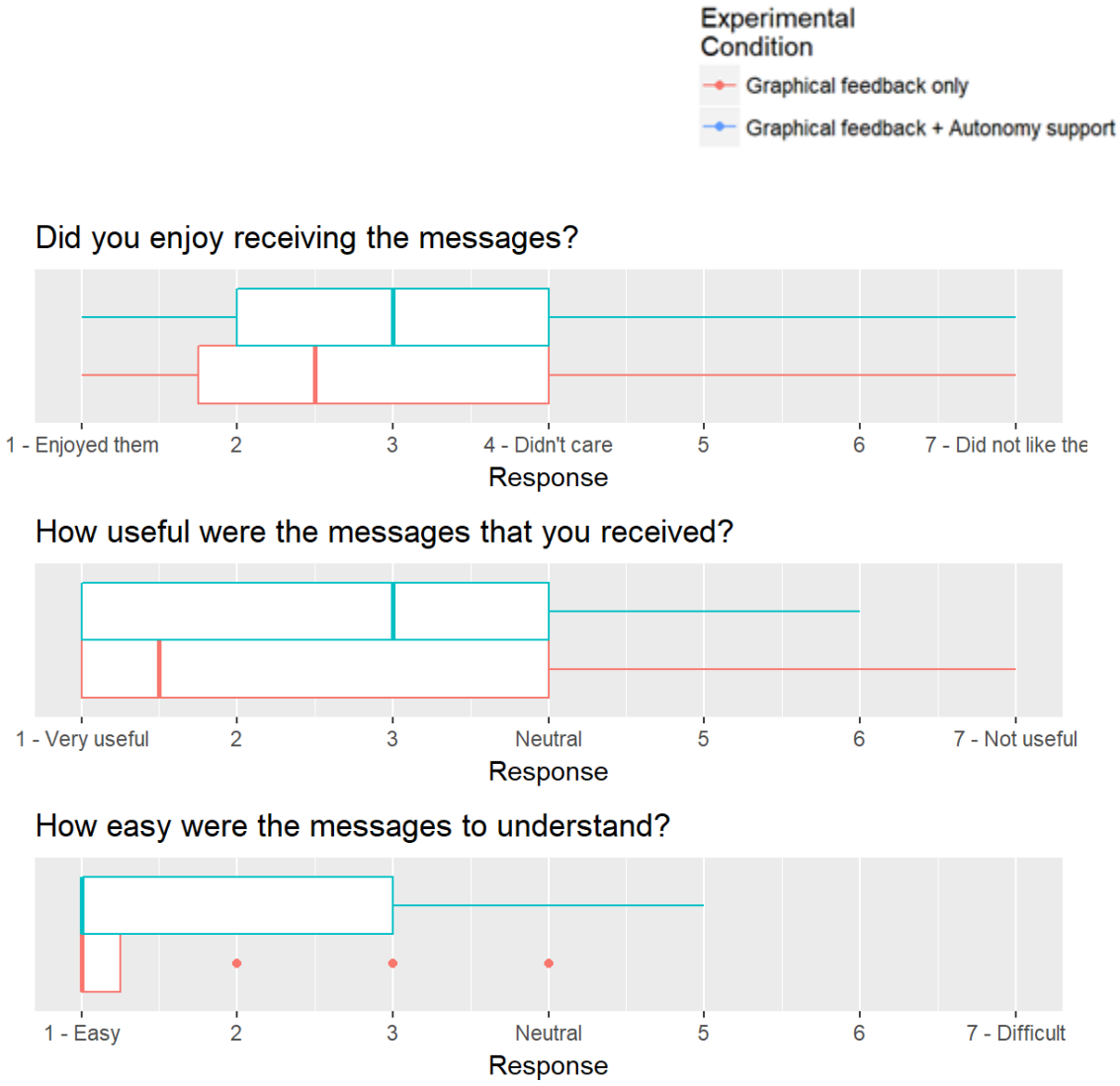


Figure 49: Study Two - Distribution of answers to acceptability questionnaire

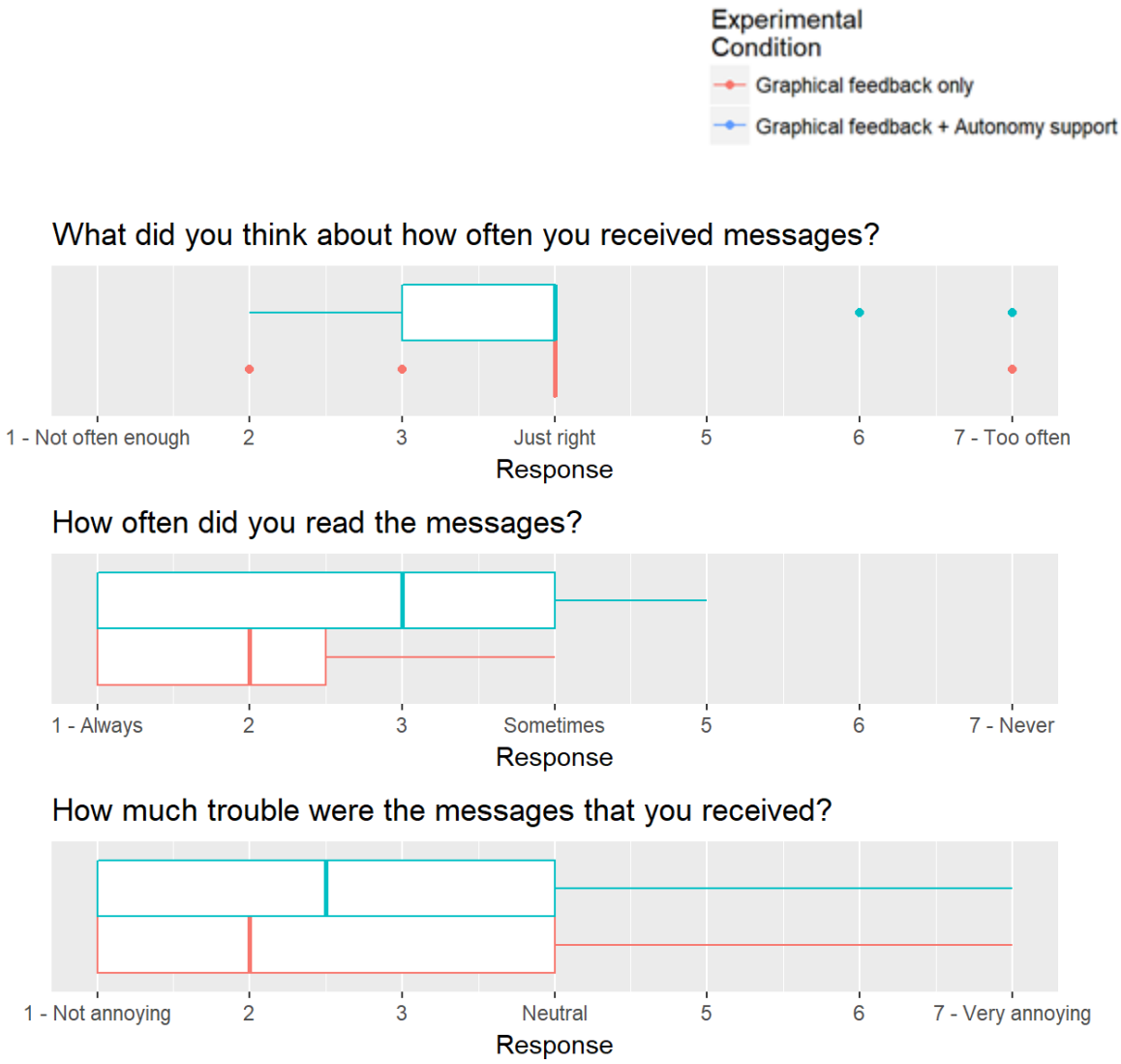


Figure 50: Study Two - Distribution of answers to acceptability questionnaire

Figure 51: Study Two - Distribution of answers to acceptability questionnaire

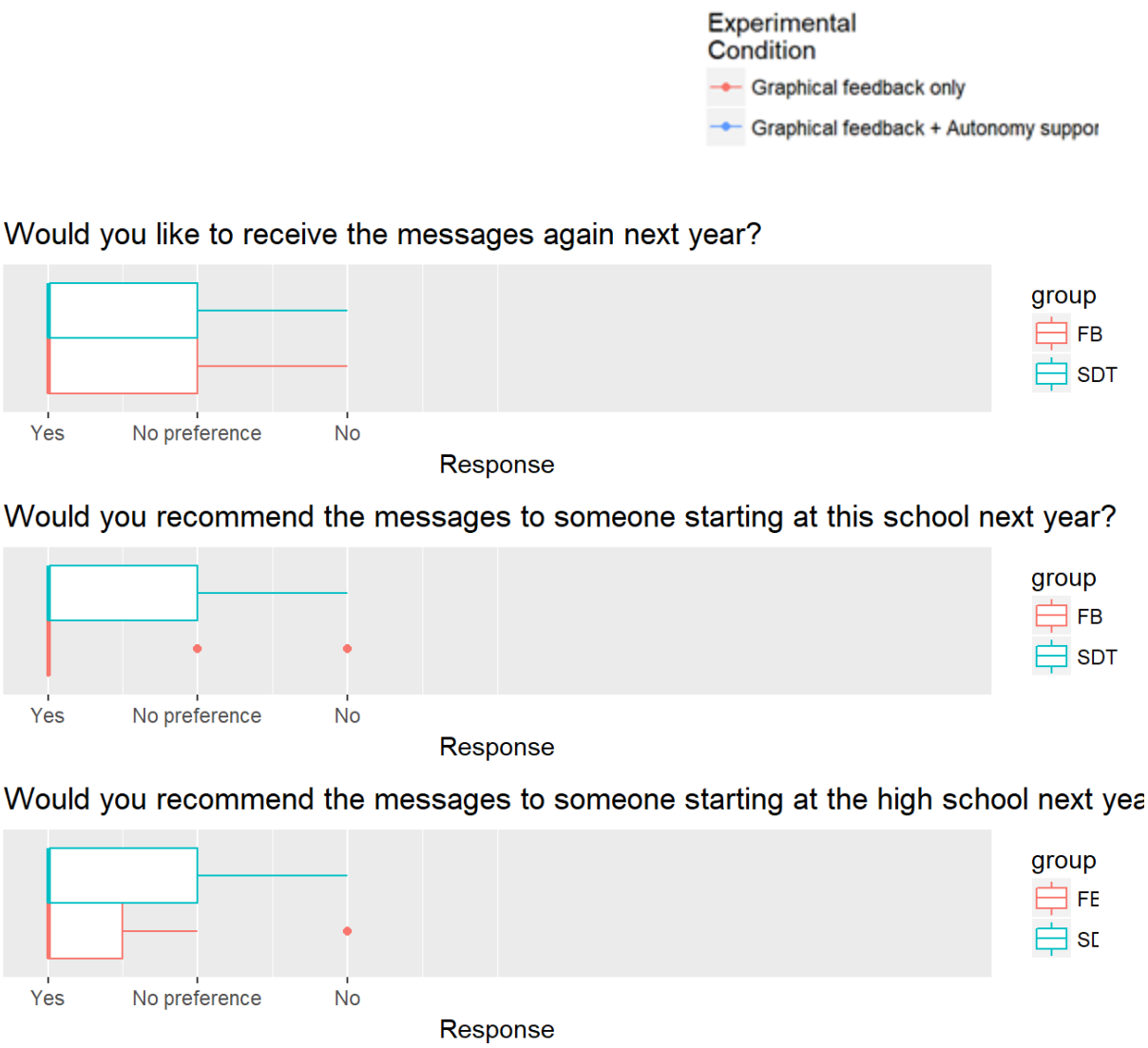


Figure 52: Study Two - Distribution of answers to acceptability questionnaire

	Feedback only (GRAPHICAL) Mean (sd)	Graphical Feedback + autonomy support (GRAPHIC + AUTMY) Mean (sd)	ANOVA
N	12	24	
Did you enjoy receiving the messages?	2.8 (1.7)	3.0 (1.4)	F(1,34)=0.09, p=0.8
How useful were the messages that you received?	2.5 (2.0)	2.7 (1.4)	F(1,34)=0.13, p=0.7
How easy were messages to understand?	1.5 (1.0)	1.8 (1.3)	F(1,34)=0.60, p=0.4
What did you think about how often you received messages?	4.3 (1.4)	4.0 (1.4)	F(1,34)=0.24, p=0.6
How often did you read the messages?	2.1 (1.2)	2.6 (1.4)	F(1,34)=1.3, p=0.3
How much trouble were the messages that you received?	2.8 (1.9)	2.7 (1.8)	F(1,34)=0.00, p=0.9
What did you think about the text in the messages? (Interesting or boring)	2.8 (1.5)	3.0 (1.7)	F(1,34)=0.13, p=0.7
Did you like the time that the messages were sent?	3.5 (1.7)	2.9 (1.3)	F(1,34)=1.3, p=0.3
Do you think you attended more?	1.9 (1.2)	2.8 (1.8)	F(1,34)=2.7, p=0.1
Do you want to receive messages next year?	1.5 (0.8)	1.5 (0.7)	F(1,34)=0.03, p=0.9
Recommend at this school	1.3 (0.6)	1.5 (0.7)	F(1,34)=1.4, p=0.2
Recommend at regular high school	1.5 (0.8)	1.5 (0.7)	F(1,32)=0.06, p=0.8
Question 1 correct			
Yes	11 (92%)	17 (71%)	
No	1 (8%)	7 (29%)	
Question 2 correct			
Yes	10 (83%)	16 (67%)	
No	2 (17%)	8 (33%)	

Table 47: Study Two - Acceptability Questionnaire mean scores